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TRANSCRIPT OF RECORD

Supreme Court of the United States

OCTOBER TERM, ~~1945~~ 1947

2

No. 184

GRAVER TANK & MFG. CO., INC., THE LINCOLN ELECTRIC COMPANY, GRAVER TANK & MFG. CORPORATION, PETITIONERS,

vs.

THE LINDE AIR PRODUCTS COMPANY

No. 185

GRAVER TANK & MFG. CO., INC., THE LINCOLN ELECTRIC COMPANY, GRAVER TANK & MFG. CORPORATION, PETITIONERS,

vs.

THE LINDE AIR PRODUCTS COMPANY

ON WRITS OF CERTIORARI TO THE UNITED STATES COURT OF APPEALS FOR THE SEVENTH CIRCUIT

PETITION FOR CERTIORARI FILED JULY 30, 1946.

CERTIORARI GRANTED OCTOBER 11, 1946.

In the
United States Circuit Court of Appeals
For the Seventh Circuit

THE LINDE AIR PRODUCTS COMPANY,
Plaintiff-Appellant.

No. 9481. *vs.*

GRAVER TANK & MFG. CO., INC., THE LINCOLN ELECTRIC COMPANY AND GRAVER TANK & MFG. CORPORATION,
Defendants-Appellees.

THE LINDE AIR PRODUCTS COMPANY,
Plaintiff-Appellee,

No. 9482. *vs.*

GRAVER TANK & MFG. CO., INC., THE LINCOLN ELECTRIC COMPANY AND GRAVER TANK & MFG. CORPORATION,
Defendants-Appellants.

Appeals from the District Court of the United States for the Northern District of Indiana, Hammond Division.

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* Each of these Exhibits was originally identified as a part of Exhibit 231 and all were offered and admitted under that number. At page 2341, the numbering of the respective X-rays included in Exhibit 231 was changed, as indicated above.

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* Each of these Exhibits was originally identified as a part of Exhibit 231 and all were offered and admitted under that number. At page 2341, the numbering of the respective X-rays included in Exhibit 231 was changed, as indicated above.

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1 IN THE DISTRICT COURT OF THE UNITED STATES.

For the Northern District of Indiana.

Hammond Division.

Pleas and proceedings had in the District Court of the United States for the Northern District of Indiana at a term of said court in Hammond, Indiana, before the Honorable Luther M. Swygert, Judge for the United States District Court, for the Northern District of Indiana, in the matter of

The Linde Air Products Company,
vs.
Graver Tank & Manufacturing Co., Inc. and The Lincoln Electric Company. } Civil 607

Be it remembered that heretofore on the 1st day of October, 1945, the above named plaintiff, by its attorney, filed in the office of the Clerk of this Court, complaint for patent infringement, which complaint reads in the words and figures following, to-wit:

2 IN THE UNITED STATES DISTRICT COURT.

(Caption—607)

COMPLAINT.

For its complaint, The Linde Air Products Company alleges:

(1) Jurisdiction of this court arises under the Patent Statutes of the United States.

(2) Plaintiff, The Linde Air Products Company, is a corporation organized and existing under and by virtue of the laws of the State of Ohio, and has an office and place of business at 30 East 42nd Street, in the City of New York, County of New York, and State of New York.

(3) Defendant, Graver Tank & Manufacturing Co., Inc., is a corporation organized and existing under and by virtue

of the laws of the State of Delaware, and has a place of business at 4809 Todd Avenue, in the City of East Chicago, County of Lake, and State of Indiana.

(4) Defendant, The Lincoln Electric Company, is a corporation organized and existing under and by virtue of the laws of the State of Ohio, and has a place of business at 314 South St. Joseph Street, in the City of South Bend, County of St. Joseph, and State of Indiana.

3 (5) On June 9, 1936, United States Letters Patent No. 2,043,960 were duly and legally issued to Union Carbide and Carbon Corporation, a corporation of New York, as assignee by means of assignments from Lloyd Theodore Jones, Harry Edward Kennedy, and Maynard Arthur Rotermund, all of Berkeley, California, for an invention in Electric Welding; and by an instrument in writing dated June 10, 1936, recorded June 11, 1936, in Liber C167, at page 247, United States Transfers of Patents, said Union Carbide and Carbon Corporation assigned said United States Letters Patent No. 2,043,960 to plaintiff, whereby plaintiff became the sole and exclusive owner of the entire right, title and interest in and to said Letters Patent, and ever since the tenth day of June, 1936, has been and still is the sole and exclusive owner of said Letters Patent.

(6) Defendant, Graver Tank & Manufacturing Co., Inc., has for a long time past been, and still is, infringing said Letters Patent by using a process of electric welding embodying the invention of said Letters Patent and by using an electric welding composition and fluxing material purchased by it from said defendant, The Lincoln Electric Company, and embodying the invention of said Letters Patent, and will continue to do so unless enjoined by this court.

(7) Defendant, The Lincoln Electric Company, has for a long time past been, and still is, infringing said Letters Patent by using a process of electric welding embodying the invention of said Letters Patent, as well as by making and using an electric welding composition and fluxing material embodying the invention of said Letters Patent, and by selling such material to defendant, Graver Tank & Manufacturing Co., Inc., and possibly others who are not licensed under said Letters Patent, and will continue
4 to do so unless enjoined by this court.

Wherefore plaintiff demands:

(1) A preliminary and final injunction against further infringement, and threats of infringement, by each of the defendants and those controlled by each of the defendants.

(2) An accounting for profits and damages.

(3) An assessment of costs against the defendants.

Cahill, Gordon, Zachry & Reindel,
63 Wall St.,
New York, N. Y.,

Carlson, Pitzner, Hubbard & Wolfe,
Ave. N. LaSalle St.,
Chicago, Ill.,

Crumpacker, May, Carlisle & Beamer,
811 JMS Bldg.,
South Bend, Ind.,

Woodson S. Carlisle,
11 JMS Bldg.,
South Bend, Indiana,
Attorneys for Plaintiff.

5 And afterwards, towit, on the 24th day of November, 1945, the following proceedings were had, towit:

Comes now the defendant Graver Tank & Mfg. Co., Inc., by its attorneys and files separate answer, which answer reads in the words and figures following, towit:

6 IN THE UNITED STATES DISTRICT COURT.

(Caption—607)

SEPARATE ANSWER OF GRAVER TANK & MFG. CO. INC.

To the Complaint filed herein the defendant, Graver Tank & Mfg. Co. Inc., makes answer as follows:

1. Defendant admits that the action as stated is one arising under the patent statutes of the United States, but as hereinafter more fully set forth denies any infringement of the Letters Patent on which the action is based.

2. Defendant admits the allegations of Par. 2 of the Complaint.

3. Defendant admits the allegations of Par. 3 of the

Complaint except that its corporate name is therein incorrectly stated to be Graver Tank & Manufacturing Co. Inc.

4. Defendant is not informed as to the incorporation and place of business of the other named defendant, The Lincoln Electric Company, so leaves plaintiff to its proof thereof.

5. Defendant admits that Letters Patent No. 2,043,960 issued to Union Carbide and Carbon Corporation on June 9, 1936, but denies that the same were duly and legally thus issued. Defendant has no knowledge regarding the mesne and other assignments referred to in Par. 5 of the Complaint whereby plaintiff allegedly became the sole
7 and exclusive owner of the entire right, title and interest in and to said Letters Patent, and therefore denies such ownership.

6. Defendant denies the allegations of Par. 6 of the Complaint.

7. Defendant has no knowledge of any infringement of said Letters Patent by The Lincoln Electric Company as alleged in Par. 7 of the Complaint and therefore denies such infringement.

Further answering the Complaint, defendant alleges:

8. Said Letters Patent are invalid and void as defendant is informed and believes for the following reasons, among others:

(a) The patentees thereof were not the original and first inventors and discoverers of the alleged inventions therein set forth and claimed or of any material or substantial part thereof, but on the contrary long prior to the alleged invention or discovery by said patentees, or more than two years prior to their application for Letters Patent, the alleged inventions and all material or substantial parts thereof were known or used by others in this country, whose residences are as given below, or were patented or described in printed publications in this and foreign countries, as follows:

U. S. Patents

No.	Name and Residence	Date
277,393	E. A. Whitcomb Cincinnati, Ohio	May 8, 1883
721,703	P. L. T. Heroult Froges, Isere, France	Mar. 3, 1903

U. S. Patents No.	Name and Residence	Date
1,070,568	R. S. Wile Pittsburgh, Pa.	Aug. 19, 1912
1,277,639	A. B. Pescatore London, England	Sept. 3, 1918
1,283,909	C. C. Roberts Mount Vernon, Ohio	Nov. 5, 1918
1,441,685	E. H. Jones London, England	Jan. 9, 1923
1,532,052	A. E. Greene Chicago, Ill.	Mar. 31, 1925
1,589,017	J. C. Lincoln Cleveland, Ohio	June 15, 1926
1,741,031	W. B. Miller Flushing, N. Y.	Dec. 24, 1929
1,748,785	W. B. Miller, et al. Flushing, N. Y.	Feb. 25, 1930
1,782,316	B. S. Robinoff, et al. Pittsburgh, Pa.	Nov. 18, 1930
1,992,792	J. M. Weed Ballston Lake, N. Y.	Feb. 26, 1935

Foreign Patent No.	Name	Date
German 313,931	N. Czako	Sept. 13, 1907

Publication

"The Iron Age"—May 17, 1931 (pp. 1502-7 inc.) Article entitled "New Pipe Mills at McKeesport Works of National Tube Co."

and others not now known to defendant which defendant begs leave to insert by amendment when discovered.

(b) The alleged inventions do not constitute patentable invention, improvement or discovery within the meaning of the patent law in view of the prior state of the art as disclosed in various patents and publications and in view of what was common knowledge of those skilled in the art at the time of the alleged inventions by said patentees.

9 (c) The inventions alleged to have been patented by said Letters Patent have been in public use and on

sale in this country for more than two years before the applications for said Letters Patent or had been abandoned to the public prior to the applications for said Letters Patent, or prior to the issuance of said Letters Patent, by the following persons at the places named:—

The several patentees of the U. S. patents hereinbefore listed under sub-paragraph 8(a) of this Answer.

The Lincoln Electric Co., at Cleveland, Ohio, and elsewhere in the United States

National Tube Co., at McKeesport, Pa., and elsewhere in the United States

Western Pipe & Steel Co., at Los Angeles, California, and elsewhere in the United States

M. W. Kellogg Co., at Jersey City, N. J., and elsewhere in the United States

General Electric Co., at Schenectady, N. Y., and elsewhere in the United States

Percy A. E. Armstrong, at New York, N. Y., and elsewhere in the United States

and others not now known to defendant, whom defendant begs leave to insert by amendment when discovered.

(d) The said patentees surreptitiously or unjustly obtained said Letters Patent for that which was in fact invented by others who were using reasonable diligence in adapting and perfecting the same as follows:—

Percy A. E. Armstrong, of New York, N. Y.

Robert K. Hopkins, of New York, N. Y.

and others not now known to defendant, whom defendant begs leave to insert by amendment when discovered.

(e) The claims of said Letters Patent are vague, ambiguous and indefinite and fail particularly to point out and distinctly claim the step, ingredient, improvement or combination claimed by the patentees as their invention or discovery.

(f) The claims of said Letters Patent cover unpatentable aggregations or exhausted combinations as distinguished from patentable combinations.

(g) The method of process allegedly disclosed by said Letters Patent is inoperative.

9. In view of the prior art and the wording of the claims of said Letters Patent and of the proceedings in the Patent Office in connection therewith, said Letters Patent are of such limited scope that they do not cover any process of electric welding or electric welding compostion or fluxing material made and/or used by defendant.

10. Plaintiff is without equity in bringing this action under said Letters Patent and does not come into equity with clean hands, because, for a number of years past, plaintiff has pursued a plan, scheme and deliberate course of conduct consisting of requiring all persons licensed under, or purchasing equipment, material or products allegedly covered by, said Letters Patent, to purchase from plaintiff all their requirements thereof and of other products, patented or unpatented, which were sold or trafficked in by plaintiff and at prices fixed by plaintiff, all in violation of Sec. 3 of the Clayton Act, 15 U. S. C. Sec. 14.

11. Plaintiff for a number of years past has been fully informed and advised as to defendant's process of electric welding and of the welding composition and fluxing material used by defendant in such process; nevertheless the present complaint has been filed without any previous notice by plaintiff of the claims and allegations made therein respecting said Letters Patent. Meanwhile defendant has continuously expanded its use of such process, composition and fluxing material and has invested additional large sums in facilities for such use. Accordingly defendant asserts that plaintiff is estopped by its conduct and prejudicial delay from maintaining this action.

Wherefore defendant prays for judgment dismissing the Complaint herein as to it, with costs.

GRAVER TANK & MFG. CO., INC.
By L. L. BOMBERGER,
5248 Hohman Ave.,
Hammond, Ind.
Its Attorney.

JNO. F. OBERLIN,
909 Leader Bldg.,
Cleveland, Ohio.

ASHLEY M. VAN DUZER,
Terminal Tower,
Cleveland, Ohio.
Of Counsel.

Service of the foregoing Answer of Graver Tank & Mfg. Co. Inc., is hereby acknowledged this __ day of November, 1945.

.....
Attorney for Plaintiff.

12 And afterwards, towit, on the 24th day of November, 1945, the following proceedings were had, towit:

Comes now the defendant Lincoln Electric Company, by its attorney, and files separate answer to the complaint, which answer reads in the words and figures following, towit:

13 IN THE UNITED STATES DISTRICT COURT.

* * (Caption—607) * *

SEPARATE ANSWER OF THE LINCOLN ELECTRIC COMPANY.

To the Complaint filed herein the defendant, The Lincoln Electric Company, makes answer as follows:

1. Defendant denies that this Court has jurisdiction in the premises, because (a) defendant is not an inhabitant of this judicial district; (b) the sole cause of action asserted is alleged patent infringement; and therefore (c) this Court can have jurisdiction only by virtue of that provision of Title 28 U.S.C., Sec. 109, which gives the District Courts jurisdiction "in any district in which the defendant * * * shall have committed acts of infringement and have a regular and established place of business", and defendant does not come within this proviso.

2. Defendant admits the allegations of Par. 2 of the Complaint.

3. Defendant is not informed as to the incorporation and place of business of the other named defendant, Graver Tank & Manufacturing Co. Inc., so leaves plaintiff to its proof thereof.

4. Defendant admits the allegations of Par. 4 of the Complaint.

14 5. Defendant admits that Letters Patent No. 2,043,960 issued to Union Carbide and Carbon Corporation on June 9, 1936, but denies that the same were duly and legally thus issued. Defendant has no knowledge regarding the mesne and other assignments referred to in Par.

5 of the Complaint whereby plaintiff allegedly became the sole and exclusive owner of the entire right, title and interest in and to said Letters Patent, and therefore denies such ownership.

6. Defendant has no knowledge of any infringement of said Letters Patent by Graver Tank & Manufacturing Co. Inc. as alleged in Par. 6 of the Complaint and therefore denies such infringement.

7. Defendant denies the allegations of Par. 7 of the Complaint.

Further answering the Complaint, defendant alleges:

8. Said Letters Patent are invalid and void as defendant is informed and believes for the following reasons, among others:

(a) The patentees thereof were not the original and first inventors and discoverers of the alleged inventions therein set forth and claimed or of any material or substantial part thereof, but on the contrary long prior to the alleged invention or discovery by said patentees, or more than two years prior to their application for Letters Patent, the alleged inventions and all material or substantial parts thereof were known or used by others in this country, whose residences are as given below, or were patented or described in printed publications in this and foreign countries, as follows:—

15

U. S. Patents No.	Name and Residence	Date
277393	E. A. Whitcomb, Cincinnati, Ohio	May 8, 1883
721,703	P. L. T. Heroult, Froges, Isere, France	Mar. 3, 1903
1,070,568	R. S. Wile, Pittsburgh, Pa.	Aug. 19, 1912
1,277,639	A. B. Pescatore, London, England	Sept. 3, 1918
1,283,909	C. C. Roberts, Mount Vernon, Ohio	Nov. 5, 1918
1,441,685	E. H. Jones, London, England	Jan. 9, 1923
1,532,052	A. E. Greene, Chicago, Ill.	Mar. 31, 1925
1,589,017	J. C. Lincoln, Cleveland, Ohio	June 15, 1926
1,741,031	W. B. Miller, Flushing, N. Y.	Dec. 24, 1929
1,747,785	W. B. Miller et al, Flushing, N. Y.	Feb. 25, 1930
1,782,316	B. S. Robinoff et al, Pittsburgh, Pa.	Nov. 18, 1930
1,992,792	J. M. Weed, Ballston Lake, N. Y.	Feb. 26, 1935

Foreign Patent No.	Name	Date
German 313,931	N. Czako	Sept. 13, 1907

Publication

"The Iron Age"—May 17, 1931 (pp. 1502-7 inc.) Article entitled "New Pipe Mills at McKeesport Works of National Tube Co."

and others not now known to defendant which defendant begs leave to insert by amendment when discovered.

16 (b) The alleged inventions do not constitute patentable invention, improvement or discovery within the meaning of the patent law in view of the prior state of the art as disclosed in various patents and publications and in view of what was common knowledge of those skilled in the art at the time of the alleged invention by said patentees.

(c) The inventions alleged to have been patented by said Letters Patent have been in public use and on sale in this country for more than two years before the applications for said Letters Patent or had been abandoned to the public prior to the application for said Letters Patent, or prior to the issuance of said Letters Patent, by the following persons at the places named:

The several patentees of the U. S. patents hereinbefore listed under sub-paragraph 8(a) of this Answer.

The Lincoln Electric Co., at Cleveland, Ohio, and elsewhere in the United States.

National Tube Co., McKeesport, Pa., and elsewhere in the United States.

Western Pipe & Steel Co., at Los Angeles, California, and elsewhere in the United States.

M. W. Kellogg Co., at Jersey City, N. J., and elsewhere in the United States.

General Electric Co., at Schenectady, N. Y., and elsewhere in the United States.

Percy A. E. Armstrong, at New York, N. Y., and elsewhere in the United States.

and others not now known to defendant, whom defendant begs leave to insert by amendment when discovered.

(d) The said patentees surreptitiously or unjustly obtained said Letters Patent for that which was in fact in-

vented by others who were using reasonable diligence in adopting and perfecting the same as follows:

17 Percy A. E. Armstrong, of New York, N. Y.
Robert K. Hopkins, of New York, N. Y.

and others not now known to defendant, whom defendant begs leave to insert by amendment when discovered.

(e) The claims of said Letters Patent are vague, ambiguous and indefinite and fail particularly to point out and distinctly claim the step, ingredient, improvement or combination claimed by the patentees as their invention or discovery.

(f) The claims of said Letters Patent cover unpatentable aggregations or exhausted combinations as distinguished from patentable combinations.

(g) The method or process allegedly disclosed by said Letters Patent is inoperative.

9. In view of the prior art and the wording of the claims of said Letters Patent and of the proceeding in the Patent Office in connection therewith, said Letters Patent are of such limited scope that they do not cover any process of electric welding or electric welding composition or fluxing material made and sold by defendant.

10. Plaintiff is without equity in bringing this action under said Letters Patent and does not come into equity with clean hands, because, for a number of years past, plaintiff has pursued a plan, scheme and deliberate course of conduct consisting of requiring all persons licensed under, or purchasing equipment, material or products allegedly covered by, said Letters Patent, to purchase from plaintiff all their requirements thereof and of other products, patented or unpatented, which were sold or trafficked in by plaintiff and at prices fixed by plaintiff, all in violation of Sec. 3 of the Clayton Act, 15 U.S.C. Sec. 14.

18 11. Plaintiff for a number of years past has been fully informed and advised as to defendant's process of electric welding and of the welding composition and fluxing material used by defendant in such process; nevertheless the present complaint has been filed without any previous notice by plaintiff of the claims and allegations made therein respecting said Letters Patent. Meanwhile defendant has continuously expanded its use of such process, composition and fluxing material and has invested additional large sums in facilities for manufacturing such composition and flux and equipment for use in such process.

Accordingly defendant asserts that plaintiff is estopped by its conduct and prejudicial delay from maintaining this action.

Wherefore defendant prays for judgment dismissing the Complaint herein as to it, with costs.

THE LINCOLN ELECTRIC COMPANY
By L. L. BOMBERGER,
5248 Hohman Ave,
Hammond, Ind.
Its Attorney.

JNO. F. OBERLIN,
909 Leader Bldg.,
Cleveland Ohio.

ASHLEY M. VAN DUZER,
Terminal Tower,
Cleveland, Ohio.
Of Counsel.

Service of the foregoing Answer of The Lincoln Electric Company is hereby acknowledged this ... day of November, 1945.

Attorney for Plaintiff.

19 And afterwards, towit, on the 16th day of March, 1946, the following proceedings were had, towit:

And now upon motion of the plaintiff, The Linde Air Products Company and upon the consent of the defendants Graver Tank & Mfg. Corp., the court now enters order adding party defendant, which order reads in the words and figures following, towit:

20 IN THE UNITED STATES DISTRICT COURT.
* * (Caption—607) * *

ORDER.

Upon motion of the plaintiff, The Linde Air Products Company, and upon the consent of the defendants and of Graver Tank & Mfg. Corp.,

It Is Ordered, that:

1. The Graver Tank & Mfg. Corp., an Indiana corpo-

ration, be and it hereby is added as a party defendant to this action;

2. The plaintiff be and it hereby is permitted to serve an amended complaint in the form annexed naming the said Graver Tank & Mfg. Corp. as a party defendant;

3. The service of such amended complaint shall be without prejudice to all the proceedings already had herein, and the separate answer of each of the defendants, The Lincoln Electric Company, and Graver Tank & Mfg. Co., Inc., to the original complaint herein shall be deemed to be said defendants' answer to the amended complaint, unless and until said defendant shall serve an answer to the amended complaint within the time allowed by Rule 15 of the Federal Rules of Civil Procedure;

4. The Clerk of this Court be and he hereby is directed to issue, upon the filing of the amended complaint annexed, an additional summons directed to the Graver Tank & Mfg. Corp., and the said additional summons shall
21 be served on said Graver Tank & Mfg. Corp., in the manner provided in Rule 4 of the Federal Rules of Civil Procedure.

Dated: March 16, 1946.

Luther M. Swygert,
United States District Judge.

We hereby consent to the making of the foregoing order.

Dated: March 12, 1946.

L. L. Bomberger,
Attorney for Defendants, Graver Tank & Mfg. Co. Inc. and The Lincoln Electric Company,

L. L. Bomberger,
Attorney for Graver Tank & Mfg. Corp.

22 And afterwards, towit, on the 26th day of March, 1946, the following proceedings were had, towit:

Comes now the plaintiff, The Linde Air Products Company, and files amended complaint, which amended complaint reads in the words and figures following, towit:

23 IN THE UNITED STATES DISTRICT COURT.

* * (Caption—607) * *

AMENDED COMPLAINT.

For its amended complaint, The Linde Air Products Company alleges:

(1) Jurisdiction of this court arises under the Patent Statutes of the United States.

(2) Plaintiff, The Linde Air Products Company, is a corporation organized and existing under and by virtue of the laws of the State of Ohio, and has an office and place of business at 30 East 42nd Street, in the City of New York, County of New York, and State of New York.

(3) a. Defendant, Graver Tank & Mfg. Co., Inc., is a corporation organized and existing under and by virtue of the laws of the State of Delaware, and has a place of business at 4809 Todd Avenue, in the City of East Chicago, County of Lake, and State of Indiana.

b. Defendant, Graver Tank & Mfg. Corp. is a corporation organized and existing under and by virtue of the laws of the State of Indiana, and has a place of business at 4809 Todd Avenue, in the City of East Chicago, County of Lake, and State of Indiana.

24 (4) Defendant, The Lincoln Electric Company, is a corporation organized and existing under and by virtue of the laws of the State of Ohio, and has a place of business at 314 South St. Joseph Street, in the City of South Bend, County of St. Joseph, and State of Indiana.

(5) On June 9, 1936, United States Letters Patent No. 2,043,960 were duly and legally issued to Union Carbide and Corbon Corporation, a corporation of New York, as assignee by mesne assignments from Lloyd Theodore Jones, Harry Edward Kennedy and Maynard Arthur Rotermund, all of Berkeley, California, for an invention in Electric Welding; and by an instrument in writing dated June 10, 1936, recorded June 11, 1936, in Liber C167, at page 247,

United States Transfers of Patents, said Union Carbide and Carbon Corporation assigned said United States Letters Patent No. 2,043,960 to plaintiff, whereby plaintiff became the sole nd exclusive owner of the entire right, title and interest in and to said Letters Patent, and ever since the tenth day of June, 1936, has been and still is the sole and exclusive owner of said Letters Patent.

(6) Defendants, Graver Tank & Mfg. Co., Inc., and Graver Tank & Mfg. Corp., and each of them, have for a long time past been, and still are, infringing said Letters Patent by using a process of electric welding embodying the invention of said Letters Patent and by using an electric welding composition and fluxing material purchased by them, and each of them, from said defendant, The Lincoln Electric Company, and embodying the invention of said Letters Patent and will continue to do so unless enjoined by this court.

(7) Defendant, The Lincoln Electric Company, has for a long time past been, and still is, infringing said Letters Patent by using a process of electric welding embodying the invention of said Letters Patent, as well as by making and using an electric welding composition and fluxing material embodying the invention of said Letters Patent, and by selling such material to defendants, Graver Tank & Mfg. Co., Inc. and Graver Tank & Mfg. Corp., and each of them, and possibly others who are not licensed under said Letters Patent, and will continue to do so unless enjoined by this court.

Wherefore Plaintiff Demands:

(1) A preliminary and final injunction against further infringements, and threats of infringement, by each of the defendants and those controlled by each of the defendants.

(2) An accounting for profits and damages.

(3) An assessment of costs against the defendants.

Cahill, Gordon, Zachry & Reindel,
By Jas. A. Fowler, Jr.,
A Member of the Firm,

Carlson, Pitzner, Hubbard & Wolfe,
By Richard R. Wolfe,
A Member of the Firm,

Crumpacker, May, Carlisle & Beamer,
By Woodson S. Carlisle,
A Member of the Firm.
Attorneys for Plaintiff.

26 And afterwards, towit, on the 25th day of November, 1946, the following proceedings were had, towit:

And now the court enters pre-trial order, which pre-trial order reads in the words and figures following, towit:

27 IN THE UNITED STATES DISTRICT COURT.

* * (Caption—607) * *

PRE-TRIAL ORDER.

This cause came on regularly for a pre-trial hearing before Judge Luther Swygert on November 15, 1946.

Appearances for Plaintiff:

Cahill, Gordon, Zachry & Reindel, of New York, N. Y., by John Cahill, Esq., James A. Fowler, Esq., and Loftus E. Becker, Esq.; Carlson, Pitzner, Hubbard & Wolfe, of Chicago, Ill., by Richard Russell Wolfe, Esq.; Crumpacker, May, Carlisle & Beamer, of South Bend, Ind., by George N. Beamer, Esq.

Appearances for Defendants:

McKeehan, Merrick, Arter & Stewart, of Cleveland, Ohio, by Ashley M. Van Duzer, Esq., and James R. Stewart, Esq.; Oberling & Limbach, of Cleveland, Ohio, by John F. Oberlin, Esq.; Wilkinson, Huxley, Byron & Knight, of Chicago, Ill., by Charles Byron, Esq.; L. L. Bomberger, Esq., of Hammond, Ind.; L. A. Bradburn, Esq., of Chicago, Ill.

28 Based upon the proceedings at said pre-trial hearing, it is

Ordered, that the admissions and agreements of the parties to the effect set forth below limiting the issues framed by the amended complaint herein and the respective answers to said complaint be, and the same hereby are, approved and adopted:

1. This is an action brought by The Linde Air Products Company, a company organized and existing under and by virtue of the laws of the State of Ohio, as plaintiff, for infringement of United States Letters Patent No. 2,043,

960, issued on June 9, 1936, hereinafter called the "Jones et al. patent." The amended complaint, in the short form annexed to the Rules of Civil Procedure in "Form 16—Complaint for Infringement of Patent", alleges the issuance of the Jones et al. patent, its ownership by plaintiff and infringement by each of the defendants.

2. The defendants named in the amended complaint are:

The Lincoln Electric Company, a corporation organized and existing under and by virtue of the laws of the State of Ohio;

Graver Tank & Mfg. Co., Inc., a corporation organized and existing under and by virtue of the laws of the State of Delaware; and

Graver Tank & Mfg. Corp., a corporation organized and existing under and by virtue of the laws of the State of Indiana.

3. By agreement by and among the respective parties to this action, it has been agreed solely for the purposes of the present action that no distinction need be made between the respective acts of Graver Tank & Mfg. Co., Inc., and Graver Tank & Mfg. Corp. in whatever proofs plaintiff may offer in support of its charge of infringe-
29 ment in this action, and that any judgment which is entered in this action shall apply in all respects both as to injunctive relief, if any, and liability for accounting and award thereon, if any, to such two Graver companies jointly and severally.

4. This action may proceed to trial and final disposition on the pleadings and proofs herein, irrespective of the prospective consolidation or merger of subsequently named Graver Tank & Mfg. Corp., a corporation of Indiana with said originally named defendant Graver Tank & Mfg. Co., Inc., a corporation of Delaware.

5. In plaintiff's designation of claims filed herein in April, 1946, plaintiff designated:

(a) Claims Nos. 1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14, 15, 16 and 17 of the Jones et al patent as process claims, each of which is alleged to be infringed by each of the defendants herein by practice of the so-called Lincolnweld welding process; and

(b) Claims Nos. 18, 20, 22, 23, 24, 26 and 27 of said patent as composition claims, each of which is alleged to be infringed by each of the defendants herein by manu-

facture, use and/or sale of the so-called Lincolnweld 660 flux.

6. By agreement by and among the respective parties to this action it has been agreed that without prejudice to the right of the defendants and each of them to contest the validity, scope or legality of issuance of the Jones et al. patent or to deny infringement thereof by the defendants and each of them, plaintiff is conceded to be the sole and exclusive owner of the entire right, title and interest in and to said patent, and ever since the 10th day of June, 1936, has been and still is the sole and exelusive owner of said patent.

7. Defendants, The Lincoln Electric Company and Graver Tank & Mfg. Co., Inc., filed separate answers to the original complaint herein and have adopted said answers as their respective answers to the amended complaint herein. Defendant, Graver Tank Mfg. Corp., was, by order of Court at the time the complaint was amended, permitted to adopt as its answer to the amended complaint herein the answer heretofore filed by defendant, Graver Tank & Mfg. Co., Inc.

8. The issue of jurisdiction raised by defendant, The Lincoln Electric Company, is waived, since irrespective of the statutory provision under which the District Courts are given jurisdiction in patent infringement actions, said defendant has openly assumed the defense of co-defendants Graver Tank & Mfg. Co., Inc., and Graver Tank & Mfg. Corp.

9. The defendants, and each of them, have waived and withdrawn the defense of estoppel pleaded in paragraph 11 of their respective answers.

10. The defendants have agreed that they will, within ten (10) days of the entry of this order, furnish to plaintiff further particulars in reference to their answers and including a specification of those of the prior patents, publications and prior uses which have been pleaded, that will be relied upon at the trial.

11. By agreement by and among the parties to this action it has been agreed that:

(a) uncertified printed copies or photostatic copies of United States Letters Patent;

(b) uncertified copies or photostatic copies of foreign letters patent;

(c) The usual printed photostatic, photographic or photolithographic copies or reproductions of United States and

foreign printed publications, such as books, periodicals, magazines and journals, including the proceedings of scientific societies or segregated copies of any of the foregoing, may be introduced and received in evidence in this cause by any party subject to any appropriate legal objections as to relevancy and materiality; and it was further agreed

that the dates of filing, the grant, acceptance, issuance
31 or publication appearing upon all letters patent shall, in the absence of proof to the contrary, be considered the dates of filing, the grant, acceptance, issuance or publication, respectively, of such patents or publications, and that the disclosure and contents of any such letters patent shall be deemed and accepted as prima facie proof of the disclosure and contents of the application therefor as filed.

12. It has been further agreed at the pre-trial conference by and among the parties to this action that the sample bags of Lincolnweld 600 flux furnished by defendant, The Lincoln Electric Company, to plaintiff on or about May 3, 1946, and the sample of said flux furnished by defendants to plaintiff at a demonstration on or about May 21, 1946, are fairly representative of the accused Lincolnweld 660 flux.

13. It has been further agreed by and among the parties to this action, subject to any legal objections as to relevancy or materiality that may be raised at trial as to introduction of the same, that:

(a) Referring to the deposition of Ross Eugene Cornwell taken on behalf of the defendants by way of adverse party examination, the plaintiff has heretofore entered into various forms of sales-purchase contracts for weld rod with certain of the licensees under one or the other of the several forms of license agreement, Defendants' Exhibits 29 to 33 inc. and 77-A to -R inc., marked for identification in the course of said deposition, said forms of Rod Contract being identified as follows:

Defendant's Exhibit 87-A is a form of such Rod Contract of which a couple were entered into during the period from 1937 to May 1938.

32 Defendants' Exhibit 87-b is the form of such Rod Contract used during the period from May 1938 to August 1939.

Defendants' Exhibit 87-c is the form of such Rod Contract used during the period from August 1939 to August 1940.

Defendants' Exhibit 87-d is the form of such Rod Con-

tract used during the period from August 1940 to September 1941.

Defendants' Exhibit 87-e is the form of such Rod Contract used during the period from October 1941 to December 1941.

Defendants' Exhibit 87-f is the form of such Rod Contract used during the period from December 1941 to July 1944.

Defendants' Exhibit 87-g is the form of such Rod Contract used during the period from August 1944 up to the present date.

(b) In about ten per cent (10%) of the cases where licensees of plaintiff under the several forms of license agreements, Defendants' Exhibits 29 to 33 inc. and 77-A to -R inc., have also entered into one of the aforesaid Rod Contracts, the date of execution of the license agreement and the Rod Contract is the same, although in some cases the actual execution may not have occurred simultaneously and such execution may have been by different individuals acting on behalf of plaintiff and the licensee and purchaser.

(c) Some of the Rod Contract having the same date of execution as corresponding license agreements are still outstanding and in effect as of this date.

It Is Further Ordered,

1. That defendants, or any of them, provide plaintiff more than twenty (20) days prior to the trial of this cause with samples suitable for chemical analysis of all prior art fluxes or reproductions thereof which defendants, or any of them, propose to offer in evidence at the trial, as well as quantities (50 lbs. of each) of such prior art fluxes or reproductions thereof suitable for operating tests on any such fluxes or reproductions thereof which defendants propose to demonstrate at the trial.

2. That plaintiff provide defendants more than twenty (20) days prior to the trial of this cause with samples suitable for chemical analysis of all fluxes or reproductions thereof which plaintiff proposes to offer in evidence at the trial on its prima facie case and any of which it is currently planning to offer in its rebuttal case with the exceptions of any regular commercial grades of Unionmelt or of Lincolnweld 660 flux, as well as adequate quantities of such fluxes or reproductions thereof suitable for operating tests, or any such fluxes or reproductions thereof which plaintiff proposes to demonstrate at the trial.

The Court has taken under advisement plaintiff's re-

quest for an order that, within ten days after the entry of such order and before trial, defendants produce for inspection and copying by plaintiff the reports, etc., requested in Items 3 and 4 of Part (b) of plaintiff's motion for the discovery and production of documents and things, pursuant to Rule 34 of the Rules of Civil Procedure, dated March 13, 1946, the ruling on said items having been reserved in the order of this Court dated April 24, 1946.

The foregoing is certified to be a record of the proceedings had at the pre-trial of this cause.

Dated and entered this 25 day of November, 1946.

Luther M. Swygert,
United States District Judge.

Approved as to form:
Carlson, Pitzner, Hubbard & Wolfe,
Attorneys for Plaintiff.
Wilkinson, Huxley, Byron & Knight,
Chas L. Byron,
Attorneys for Defendants.

34 And afterwards, towit, on the 5th day of December, 1946, the following proceedings were had, towit:

Come now the defendants and file notice pursuant to pre-trial order, which notice reads in the words and figures following, towit:

35 IN THE UNITED STATES DISTRICT COURT.
• • (Caption—607) • •

NOTICE PURSUANT TO PRE-TRIAL ORDER.

Cahill, Gordon, Zachry Reindel,
New York, N. Y.
Carlson, Pitzner, Hubbard & Wolfe,
Chicago, Ill.
Crumpacker, May, Carlisle & Beamer,
South Bend, Ind.

Gentlemen:

Pursuant to the provisions of par. 10 of the Pre-Trial Order heretofore entered herein, we furnish you further particulars in reference to the prior patents and publications that will be relied upon at the trial.

These will include:

1. The prior patents and publication cited in par. 8(a) of defendants' respective answers.

2. The patents cited against the applications of Messrs. Jones et al Serial Nos. 657,836, 705,892 and 44,142 (see Defendants' Exhibits 3, 4 and 5 for identification), which are not included in item 1 hereof.

3. The collection of patents of Messrs. Jones et al comprised in Defendants' Exhibit 6 for identification.

36 4. The patents of Mr. J. M. Keir comprised in Defendants' Exhibits 48 to 53 inc. for identification.

5. The following additional patents:

1,041,525—A. P. Stromenger	Oct. 15, 1912
1,241,899—P. A. E. Armstrong	Oct. 2, 1917
1,467,825—J. C. Armor	Sep. 11, 1923
1,599,056—H. D. Lloyd et al	Sep. 7, 1926
1,733,795—J. B. Green	Oct. 29, 1929
1,754,566—W. B. Miller	Apr. 15, 1930
1,909,217—R. Notvest	May 16, 1933
1,953,942—R. R. Applegate	Apr. 10, 1934

Wilkinson, Huxley, Byron & Knight,
Chas. L. Byron,
Of Counsel for Defendants.

Dated: Dec. 3, 1946.

Service of the above notice acknowledged this 3rd day of December, 1946.

Carlson, Pitzner, Hubbard & Wolfe,
Counsel for Plaintiff.

37 And afterwards, towit, on the 6th day of December, 1946, the following proceedings were had towit:

Come now the defendants and file notice pursuant to pre-trial order which notice reads in the words and figures following, towit:

38 IN THE UNITED STATES DISTRICT COURT.

(Caption—607)

NOTICE PURSUANT TO PRE-TRIAL ORDER.

Cahill, Gordon, Zachry & Reindel,
New York, N. Y.

Carlson, Pitzner, Hubbard & Wolfe,
Chicago, Ill.

Crumpacker, May, Carlisle & Beamer,
South Bend, Ind.

Gentlemen:

Pursuant to the provision of par. 10 of the Pre-Trial Order heretofore entered herein, we furnish you further particulars in reference to the prior uses cited in par. 8(c) of defendants' respective answers.

These will include:

The Lincoln Electric Company at Cleveland, Ohio, and elsewhere in the United States;

National Tube Co. at McKeesport, Pa., and elsewhere in the United States; and

Western Pipe & Steel Co. at Los Angeles, Calif. and elsewhere in the United States.

You are further notified that defendants do not expect to rely at the trial on the defense set up in par. 8(d)
39 of their respective answers; however defendants expect to show with respect to Robert K. Hopkins of New York, N. Y., named in said paragraph,

1. That following issuance of the Jones et al. patent No. 2,043,960 in suit, pursuant to the law in such case made and provided, two interferences, viz. Nos. 73,409 and 74,901,

were declared between said patent and a then pending application or applications of said Hopkins; and

2. That plaintiff as assignee of said patent in suit, and The M. W. Kellogg Company as assignee of the application or applications of said Hopkins, agreed to and did settle said interferences without the taking of proofs as to priority of invention and without any adjudication by the Patent Office based on such proofs.

You are further notified that at the trial defendants will undertake to show that said Jones et al. patent in suit is invalid and void in view of misrepresentations made to the Patent Office in the application Serial No. 44,142 whereon said patent was granted and in prior applications of said Jones et al. Serial Nos. 657,836 and 705,892 whereof said application Serial No. 44,142 was allegedly a continuation, and in the course of prosecution of said applications, respectively.

Wilkinson, Huxley, Byron & Knight,
Chas. L. Byron,
Of Counsel for Defendants.

Dated: Dec. 5, 1946.

Service of a copy of the foregoing Notice hereby acknowledged this 5th day of December, 1946,

Carlson, Pitzner, Hubbard & Wolfe,
Richard Russell Wolfe,
Counsel for Plaintiff.

1 IN THE DISTRICT COURT OF THE UNITED STATES

For the Northern District of Indiana,

Hammond Division.

The Linde Air Products Company, *Plaintiff*,

vs.

Graver Tank & Mfg. Co., Inc., The Lincoln Electric Company, and Graver Tank & Mfg. Corp., *Defendants*.

Civil Action No. 607.

Record of Proceedings In The Above-Entitled Cause before the Honorable Luther M. Swygert, United States District Judge, at Hammond, Indiana, commencing Thursday, January 2, 1947, at ten o'clock A. M.

Appearances:

Cahill, Gordon, Zachry & Reindel, of New York, N. Y., by John T. Cahill, Esq., James A. Fowler, Esq., and Loftus E. Becker, Esq.; Carlson Pitzner, Hubbard & Wolfe, of Chicago, Illinois by Richard R.
2 Wolfe, Esq.; Crumpacker, May, Carlisle & Beamer, of South Bend, Indiana, by George N. Beamer, Esq., representing the plaintiff;

McKeehan, Merrick, Arter & Stewart, of Cleveland, Ohio, by Ashley M. Van Duzer, Esq., and James R. Stewart, Esq.; Wilkinson, Huxley, Byron & Knight, of Chicago, Illinois, by Charles L. Byron, Esq.; Oberlin & Limbach, of Cleveland, Ohio, by John F. Oberlin, Esq.; L. L. Bomberger, Esq., of Hammond, Indiana, representing the defendants.

Proceedings.

125 Mr. Cahill: If the Court please, I should like at this time to offer a copy of Patent No. 2,043,960 in evidence.

The Court: Is there any objection?

Mr. Byron: None whatsoever.

The Court: Admitted.

127 (And thereupon said PLAINTIFF'S EXHIBIT 124 was admitted in evidence.)

Mr. Cahill: I should next like to offer in evidence as Plaintiff's Exhibit 125, 126 and 127 respectively, certified copies of the three patent applications, with reference to the patent, Exhibit 124, in evidence.

130 The Court: Well, they are admitted, subject to any further observations which counsel may desire to make.

131 (Thereupon said documents, PLAINTIFF'S EXHIBITS 125, 126 and 127, were admitted in evidence.)

132 Mr. Cahill: With the Court's permission, the plaintiff will now call Mr. Harry Edward Kennedy as its first witness.

HARRY EDWARD KENNEDY, a witness called on behalf of the plaintiff, having first been duly sworn, testified as follows:

Direct Examination by Mr. Cahill.

Q. Mr. Kennedy, will you please give your full name and address to the Court Reporter?

A. My name is Harry Edward Kennedy.

Q. Where do you live?

A. 18 Yale Circle, in Berkeley, California.

Q. Are you one of the patentees under U. S. Patent number 2,043,960?

A. I am.

Q. Have you had any other patents issued to you?

A. Yes, sir, I have had a considerable number.

Q. Covering what subjects?

A. Covering the preservation and cleaning of eggs;

133 a diesel injection system; an ignition system; electric furnace patents; and applications for stress relieving of welds. An electronic device for directing a milling machine to cut out irregular shapes; and also others that I cannot recall just at the moment.

Q. Have you covered such a wide variety of subjects for any particular reason, Mr. Kennedy?

A. Yes, because I am a free-lance inventor, and you must choose a new field where you can make a big advance, rather than a small incremental amount that you might

make if you are working as a research man for a large corporation.

For instance, if you wanted to make an improvement in a carburetor, it would mean you would have to use more promotion than invention, so I have chosen to limit myself to the things wherein there was a real opportunity to make an advance, and that is why I have apparently
134 flitted about from one subject to another.

Q. What is your education, Mr. Kennedy?

A. I am a graduate of the University of California, the class of 1914.

Mr. Byron: 19 what?

The Witness: 1914, with the title of Bachelor of Science in electrical engineering.

By Mr. Cahill:

Q. What is your business and professional experience?

A. I have been a research engineer practically continuously since my graduation.

Q. What have you done since graduation?

A. I have operated a shop, you might call it, in which I have sought to accumulate as many instruments as I could have about me; and I have just chosen to try the solution of one problem after another.

Q. Is this properly called an experimental shop?

A. It is exclusively that. I do nothing but experimental work.

Q. How long have you had this experimental shop?

A. Well, this particular one I have had for about 15 years.

Q. Since about 1930, approximately?

A. Yes.

135 Q. What do you have in that shop?

A. Well, I have a complete machine shop. I have a complete sheet metal shop. I have complete welding equipment. I have all facilities as far as electrical experiments are concerned. I have dynamometers for testing engines. In fact, anything that at any time could be useful, I have sought to acquire it.

Q. Do you have any connection presently with the University of California?

A. At the present time I am a research associate in the University of California.

Q. In what field?

A. In engineering.

Q. Have you ever acted as a consultant or a liaison person between the University of California and any other body?

A. Yes. I have been the consultant for the University of California in those projects that they have recently undertaken in connection with war work.

Q. Are you a member of any welding society?

A. I am a member of the American Welding Society.

136 Q. Have you on occasion read any professional papers before meetings of that society?

A. I have read two.

Q. Have you on any occasion worked in connection with the Navy of the United States?

A. Yes. I have developed a joint for the magnetic cable which they use to detect magnetic mines.

Q. Can you tell us whether or not you have received any awards in the field of welding?

A. I have not received an award. I have notification from the American Welding Society that my paper, The Behavior of Mild Steel—The Brittle Behavior of Mild Steel—had been adjudged worthy of the Lincoln Medal, but I have not been awarded it because I was not present at its presentation in November, and the present plan is to award it in March, in San Francisco. It is awarded at the meeting of the Society, the American Welding Society.

Q. Of what is this medal made, Mr. Kennedy?

A. I have not seen the medal.

Q. I want to direct your mind to the South San Francisco plant of Western Pipe & Steel in 1932, and I put to you the question, sir: Did you at or about that time make a visit or visits to that plant?

137 A. I did.

Q. Did you in connection with such visit look at the automatic welding process in use at the South San Francisco plant of Western Pipe?

A. Yes, sir, I did.

Q. When, according to your best recollection, did you so do?

A. I think in May of 1923.

Q. Will you tell his Honor what you saw at that time when you so looked at the automatic welding process in use at that place?

A. Well, the Western Pipe & Steel Company were at that time engaged in the manufacture of pipe for the water system for San Francisco, which was called the Hetch-Hetchy water system.

This pipe was rather large and formed of two plates. The plates were rolled into a semicircular shape and the two halves put together, and they were making two longitudinal welds with automatic machines.

The welding machines were perfectly conventional. I had seen them before. They were the conventional General Electric Company heads that we used in bare wire welding, but the element that was different, that I had never seen before, was that the weld was covered with a deep
138 layer of powdered clay through which the electrode passed and played through as it traversed the weld.

Furthermore, I had never seen as large a current as they were using at Western Pipe & Steel. It was about 600 amperes, whereas I do not think I had ever seen anything more than 400 amperes before.

The welding action was different than anything I had ever seen before, too, because there was a violent outburst of fire and clay; clay particles were projected through the air by the violence of the action that was taking place under the clay blankets.

That was what I observed, and those two facts, an increased current and covering the weld with clay, were the two new facts that I saw.

Q. Is what you saw on that occasion, which you have just described, set forth on the first page of the Unionmelt patent?

A. It is.

Mr. Byron: Now, may I suggest that we refer to the Jones, et al. patent, because there are about 12 Unionmelt patents, in their license agreements. I would like to know, and I would like to have the record clear what he is
139 talking about. If he is talking about a particular patent, he should make reference to it, and not some group of patents.

By Mr. Cahill: I have no objection. I will refer the witness to the Jones-Kennedy patent.

By Mr. Cahill:

Q. Will you answer the question, Mr. Kennedy.

A. It describes exactly what we saw over there with one

modification. We said that they used currents up to 900 amperes in our patent, whereas I had never seen anything over 600 amperes.

We gave them the benefit of the doubt of having 900 amperes, because they did make one experimental weld we were aware of at 900 amperes, but substantially it describes the operation, as we saw it at Western Pipe.

Q. Referring again to the description of the operation that you saw at Western Pipe as recorded on the first page of your patent, I ask you: What, if any, part of that description on the first page of your patent did you write?

A. I wrote the first application in its entirety. It has been subsequently edited and changed to some de-
140 gree in the subsequent applications. I was responsible for the first application and the modifications are from our patent counsel.

Q. Well, referring again to the first page of the patent, can you tell us whether or not you wrote substantially the description of what you saw at the South San Francisco plant?

A. I would say that I had.

Q. Now, did you meet a man named Delhi at the South San Francisco plant of Western Pipe?

A. I did.

Q. Was his position at that time that of assistant manager of that plant?

A. That was my understanding.

Q. Did you look at completed welds made by this clay flux process at that plant?

A. I looked at many.

Q. What did you observe on inspection and examination of completed welds made by this clay flux process at the South San Francisco plant of Western Pipe?

A. That the weld had sort of a peanut shell effect, but more to the point was my observation of the many coupons around the plant, which coupons had been welds broken apart which exposed a series of holes that would run down through the line of the weld.

Mr. Cahill: I ask that this paper, being a letter
141 dated December 5, 1931, be marked for identification as Plaintiff's Exhibit 128.

(Thereupon said document was marked Plaintiff's Exhibit 128 for identification.)

142 Mr. Cahill: Plaintiff's Exhibit 128 for identification (Defendants' Exhibit 11-4) referring to the number given it on the deposition.

By Mr. Cahill:

Q. I show you Plaintiff's Exhibit 128 for identification, and ask you to look at it, if you will; and I ask you for your best recollection as to whether you saw Plaintiff's Exhibit 128 for identification at or about the time of your visit or visits to the South San Francisco plant of Western Pipe and Steel, that you have described?

A. I saw the letter.

Q. And that letter purports to be written by the assistant manager, whose name you gave as Mr. Delhi?

A. That is correct.

Mr. Cahill: I offer Plaintiff's Exhibit 128 for identification in evidence.

Mr. Byron: No objection.

(Thereupon said PLAINTIFF'S EXHIBIT 128 was received in evidence.)

Mr. Cahill: Does your Honor want to examine it?

(Handing document to the Court.)

143 The Court: Why don't you state in substance what it is?

Mr. Cahill: This is a letter from Mr. Delhi, your Honor, the assistant manager of Western Pipe, to a gentleman name Lester of the War Department, the Watertown Arsenal, and he tells Mr. Lester that he has forwarded to Mr. Lester by express a box containing fourteen samples of Western Pipe automatic electric weld, and he says—and I am not purporting to read it exactly, but giving the substance, although this is a quotation:

"We are particularly concerned at this time about the worm holes that show to a certain extent in all of the samples, with the possible exception of one, and which are more apparent in the heavier welds than in the lighter."

144 Then while I would hope that your Honor at a subsequent time would read all the letter, I shall skip to the very end of it and read the concluding three paragraphs. They are as follows:

"You may make such examinations and conduct such tests as you deem necessary to form an opinion as to the nature and causes of these holes, and trust that you can

make the necessary arrangements with the Commanding Officer for conducting these tests, advising us regarding the cost, which we will of course immediately compensate the Department for.

"We appreciate the fact that this may not be a simple problem and may entail some rather lengthy and costly experiments and possibly some radical changes in our equipment, but if you think that through our combined efforts these holes can be eliminated we will naturally desire to engage your personal services in a manner satisfactory to yourself, in order that we may diligently prosecute this work."

145 By Mr. Cahill:

Q. You say you personally observed the welds that were made by this clay flux process at the plant, at Western Pipe?

A. I did.

Q. Will you tell us what you saw when you examined the completed welds at that place?

A. I saw the completed weld had, as I mentioned before, a peanut shell effect, but again, as I said before, the place fairly reeked with samples broken in tests, bars which showed a series of holes in the weld; and it was a problem which the management and almost every individual in the plant was concerned with.

Q. By the way, do you know if Mr. Lester ever undertook the employment suggested in Plaintiff's Exhibit 128?

A. My understanding is that he did not.

Q. Do you know whether or not a similar offer of employment was made to a Mr. Stroebel?

A. I knew that a Mr. Stroebel was offered it, and engaged in an effort to solve the problem.

Q. And do you know whether or not Mr. Stroebel solved the problem that was confronting Western Pipe and Steel?

146 A. I am sure that he did not solve it.

Q. Did there come a time thereafter when you and Mr. Rotermund and Jones undertook work on automatic electric welding at the South San Francisco plant of Western Pipe?

A. We undertook to solve the problem, yes.

Q. And when did you make that beginning?

A. I think it was in May, 1932.

Q. How long did you continue your experimental work at the South San Francisco plant, that you have described?

A. Until about November or December.

Q. Now, what arrangements did you make with Western Pipe as to the basis on which such work was to be done?

A. Our arrangements were these: That we would proceed on our own, without compensation. If we failed to accomplish anything, they would be under no obligation to us; and if we did accomplish something, then we might discuss it after we accomplished it. Our plan was that they were to have a free license to use whatever we might develop.

Q. Did you know of any work being done at Western Pipe with regard to penstock for Boulder Dam?

147 A. Yes, I did. They were welding a representative section of the Boulder Dam penstock, and the object was to determine the cost of making such a weld. So they had a welder make welds, and a timekeeper keeping the time, and weighing the electrodes that were consumed.

Q. How were they making that weld?

A. By hand.

Q. What was your first and immediate objective of your work at Western Pipe?

A. Our first and immediate objective was to cure the holes.

Q. And how long did you continue on that particular objective?

A. A very short time, because we really concluded that there was no point in we three repeating the experiences that the other people went through, because there were just two or three variables—you could vary voltage or current or travel—and we were perfectly certain they had all been explored before we arrived. So we felt there was something fundamentally wrong with the process, although the management inclined to the belief it was something wrong with the equipment.

148 Q. So after you made the decision, how long did you attempt to improve the existing clay flux process in the plant, and what did you thereafter do?

A. We came to the conclusion the Robinoff process worked by reason of exuding a tremendous volume of gas which surrounded the arc, and in principle that it was using about the same principle as the flux-covered rod which sought to enclose the arc in a gaseous envelope; so

with this tremendous volume of gas being exuded from the welding zone, it was not surprising there were holes in the weld. So we concluded the source of this gas was a chemical reaction that was taking place in the flux through the agency of the high temperature in the arc, so we determined to supply a material that was not deleterious to metals, in which the chemical reaction had been entirely completed by subjecting the materials to the highest possible heat, and use that instead of the flux that we found.

So in order to accomplish this or to test this hypothesis, we turned about to the easiest way of getting such a material.

We had—at least I had some familiarity with a
149 cupola, having run one, and we got some cupola slag, ground the slag, laid it on the weld in exactly the same way the clay material had been laid before. We put the electrode down, and started the operation; but the amazing thing about the whole thing was we no longer had the violent blast of flux in the air, nor did we see any fire or pyrotechnics. In fact, we didn't know what was happening.

The wire was feeding in, and there was consumption of the wire. That is all we did have, but the instruments showed normal values.

When we unearthed the weld, we found we had an entirely different looking weld, nor were there any holes in the slag that we removed from the weld, as contrasted with the slag we removed from the weld when the clay was used.

Q. Now, during the period of May to November, 1932, that you were engaged as you have told us at the South San Francisco plant, I ask you did you do anything else but work on this problem?

A. That is practically all we did.

Q. Now, I would like to ask you as to the routine of your work at Western Pipe. What time of the day did you customarily get to the plant?

150 A. We arrived about four o'clock, and the conditions—

Q. Four o'clock in the morning?

A. In the afternoon.

Q. In the afternoon.

A. And the conditions that made this come about were

these: First the plant was generally shut down after four o'clock, and both Rotermund and Jones had other duties, and I could shift my time to theirs; so we usually got over there at four o'clock, began operations, and we made anything from the last boat to the first boat the next morning.

Q. Was the plant generally shut down when you got there?

A. Yes, it was.

Q. How many hours do you estimate you and Mr. Jones and Rotermund spent in evolving the invention covered by your patent?

A. Of course, it is an estimate, but to the best of my knowledge it would be about a thousand hours.

Q. How many welding tests did you make in connection with the work that you have told us about at Western Pipe, from May to November, 1932?

A. We made about 500.

151 Q. How many different flux compositions did you make in connection with that work?

A. I think in the order of 74 or 75.

Q. Now, turning to cupola slag, why did you select cupola slag as the material for your first flux?

A. Because we felt that all the components of cupola slag were satisfactory for use with metals, with steel, because they had already proven themselves so.

Q. Was there any characteristic of cupola slag in regard to its having been heated once already?

A. The important point, of course, was that in having passed through the cupola, it had been subjected to a high temperature, so that no further chemical reaction was possible. It had already reacted.

152 Q. And after it had cooled, you thereafter employed it, as I understand, as you first flux in connection with these 500 welding tests that you made?

A. It was the first flux; and that element of prefusion dominated every experiment from there on except for little experiments to check ourselves. The element of prefusion was made clear to us as soon as we made the first weld.

Q. Did you find cupola slag as a flux satisfactory?

A. Not satisfactory. It was the novelty of the operation and the smoothness of the weld that intrigued us. We knew it wasn't a satisfactory answer.

Q. Did you attempt any changes in regard to the kind

of electric current that you used in connection with these experiments at this plant?

A. Yes, we did. The plant was equipped with direct current, and the previous process had used direct current; but we thought that there might be a possibility of the holes being the result of electrolysis.

Now, when a direct current is passed through a fluid conductor, it electrolyzes that and may evolve a gas at one of the electrodes.

Q. What do you mean by the word "electrolyze," Mr. Kennedy?

A. Whenever a current is passed through a fluid
153 conductor, through a liquid, the components of that liquid may separate and one go to one pole—one component go to one pole and the other component to the other.

Now, if it so happens one of those components is a gas, it will evolve a gas at that electrode. You can electrolyze water by passing a direct current through it, in which hydrogen will evolve at one pole and oxygen at another.

We thought possibly a similar reaction might happen with the flux; so we substituted alternating current for direct current, because it reversed itself and might undo on one cycle what had been done on the other one, the previous one.

Q. How often does alternating current reverse itself?

A. About 60 times a second. I think Buffalo had 25 cycles.

Q. What, to your knowledge, has been the belief as to the inability to use A.C. current in connection with welding, electric welding, prior to your employment?

A. We had never heard of it being used with bare wire certainly, and no other application did we know of. In fact, we approached the experiment with considerable trepidation, because we had to move a transformer into the plant and didn't know if it would work. The
154 minute we started it we found it worked as good as the direct.

Q. I take it from your answer you had heard of the use of A.C. current in connection with coated rods.

A. No, I hadn't heard of it with a coated rod at that time. I know of it now, but not then.

Q. In so far as a bare rod is concerned,—

A. With a bare rod it is utterly hopeless. There is a period where the current passes through zero, the arc is

extinguished, and it doesn't rekindle itself or reignite; so it is impossible to maintain an arc on alternating current with a bare wire.

Q. That was true, certainly, so far as you knew until the time of your experiments at the South San Francisco plant?

A. And is true.

Q. And there you did successfully employ A.C. current in connection with the bare rod?

A. That is true.

Q. What manifestation or lack thereof did you notice in the appearance of the welding process itself after you commenced the employment of cupola slag as your flux material?

A. Well, it is obvious it was not entirely satis-
155 factory, but nevertheless we decided on the components of cupola slag, that is, calcium oxide and silica, which are the main constituents of cupola slag; we decided on those components and we decided to add to those components other known fluxes.

We added borax, iron oxide and sodium carbonate, but in every instance we fused them and it was not very long before we fused them electrically.

That is, we made an iron pot and we put the materials in the pot and we connected one pole of the generator to the—of the transformer to the pot, and the other pole was a carbon electrode which we immersed in the pot. At the start, the carbon electrode was in contact with the bottom of the metallic pot and we lifted the electrode slightly and it began probably to be an arc, but directly it began to melt the flux, so we immediately had an iron pot full of fused molten flux and it was quite evident that it was conducting a current, because on occasions a hole would appear in the side of the pot due to the current concentrating at that spot and burning a hole in the pot.

So that we had experience with—or at least, it was brought to our attention that the flux which we were using
156 was an excellent conductor of electricity, as it could carry a very great amount of current.

Q. Did the change from direct current to alternating current have any effect on the amount of current that you could employ?

A. It changed the amount available. With the transformer, we had it up to 1700 amperes, where we had only

900 before, so that it made available to us a very high degree—or a very high amount of current.

But with the flux, the cupola slag, in which we used these known fluxing materials, sometimes we would advance, and sometimes it would be a retrogression. We would make a flux, and there was an infinite number of variables that we had to contend with. For each flux, there might be four or five different voltages which that flux could be run at, and there were any number of currents, and at any travel speed.

Then we had to resolve these components, and ascertain whether or not a thing was desirable in each flux; that had to be found out.

For instance, after we had used borax for a considerable period of time, we began to suspect it as a source of cracks.

Borax contains sodium, boron and oxygen, so natur-
157 ally, sodium and boron were suspect.

Now, to find out what was making the trouble, to put the finger on the one, was our problem; so then we went to boracic acid, and we eliminated sodium, but we still kept in the boron, and we found that we still had cracks, so then, to be sure of ourselves, we added boracic acid, and then there were plenty of cracks; and then we knew that boracic acid was out.

We did the same thing with our iron oxide. We were not conscious of the fact that iron oxide was as serious a source of holes as it was, and we gradually got to the place where we found we must eliminate iron oxide as a fluxing material, and so we ultimately got down to calcium silicate, and then added a new component, a basic component, magnesium, and so we came up with a calcium magnesium silicate.

But at that time, we became more ambitious each time, and tried to weld thicker and thicker plates.

Our first knowledge that this flux was capable of welding a thick plate, came about even back in the cupola slag days, because we had taken a half-inch plate, and run a
pass on it, and penetrated it without any trouble at
158 all, which was incredible in our minds at that time, because they were only welding a half-inch plate at the plant, and it was completely V'd down; so, as I say, we became more ambitious to weld heavier and heavier plates.

When we got up to about an inch and a half, we could not get full penetration and a satisfactory looking top.

After all, there is an esthetic side to welding; you have got to make something that is not too rough.

Q. What do you mean by "full penetration"?

A. I mean, where the weld was fused all the way to the bottom. You have got to get right down to the bottom of the weld metal, if the weld is to be completed. Obviously, if it only goes through half way, you have less than half the strength that it would have if it was fully penetrated. I say, less than half the strength, because I am thinking of the notch that would be left, which complicates the stresses.

But anyway, we could not get a satisfactory top, and full penetration, so we went at it this way: We knew that a low voltage tends to produce deep penetration, and that a 159 high voltage tends to smooth out the top, very much like if you have a hose, and you hold it up close, you expect to dig into the ground with it, while if you pull it back, you might expect to smooth it out a little bit. That analogy may not be accurate, but it is somewhat parallel.

So we put on a timing relay, or a timer on our relay, so that we would weld at, say, 15 volts for five seconds, and then the timer would change, and then we would weld at 40 volts for another length of time, and so on, completing the process.

At that time we had introduced calcium fluoride. The calcium fluoride came to our notice through good fortune. We melted our flux primarily in an oil-fired furnace, and not in the electric pot. The electric pot would be a little supplementary experiment that we made.

With this oil-fired furnace, we had more difficulty in fusing, because calcium oxide and sand are very infusible materials, and so we acquired calcium fluoride, because it is a very useful material to liquefy slags; and so we were using this calcium fluoride.

I am not sure whether or not we introduced the calcium fluoride in our flux prior to our use in the furnace, 160 but I know that its use was for the purpose of making melting easy; and we found that when the flux contained a suitable amount of calcium fluoride, we no longer had any use for, or any need of, this time-controlled relay.

We welded, and we had full penetration, and a goodlooking top, even in plates up to two inches thick. So we concluded that we had exhausted—or that we had performed sufficient experiments on calcium magnesium silicate, to have a commercial and usable flux.

164 Q. Reverting to the change from D.C. to A.C. current, I ask you, Mr. Kennedy: Have you found any limitation on the amount of A.C. current that can be used under the invention covered by your patent?

A. We have never reached the limit. The highest 165 currents that we have been able to use have welded successfully.

Q. Have you discovered any plate too thick to be welded by the process disclosed by your patent?

A. I know of no thickness that we cannot weld. It becomes an impractical thickness to weld, but I think it could be welded.

Q. May I ask you the same question in respect to D.C. current that I asked you in respect to A.C. current with regard to the invention disclosed in your patent?

A. There is no limitation to direct current, as far as I know.

Q. Now, reverting to the question of glare or spatter, can you tell us whether or not you noticed any change in that regard after you commenced to use a pre-fused flux?

A. Very definitely. The cupola slag was a pre-fused flux. The cupola did it for us, but the minute we used it, the entire phenomenon changed. We had no more blast of the arc. We had no more noise and we had no stream projected in the air.

As a matter of fact, previously there was a constant stream of clay projected into the air. Everything in the place was covered with a layer of clay dust which had 166 been projected from the action of the arc under the clay.

Q. Did you make any tests to determine the conductivity of the melt?

A. Well, we measured its relative conductivity; that is, its electrical conductivity. It is an exceedingly difficult thing to measure what, to an electrical engineer, is specific resistance.

That is, you can compare the resistance of aluminum, we will say, with copper because you can get equal cross-sections, but when you take a material that is normally an insulator and becomes a conductor when it gets very hot, it is almost impossible to measure its specific resistance; but you can measure its relative resistance as compared with something else under the same circumstances, and we made many of these tests.

167 Q. Was there existing prior to your invention some limitation of which you were aware as to the amount of metal which would be deposited in a weld in a single pass with a coated rod?

A. Yes. The coated rod was capable of depositing about one-eighth of an inch, a layer one-eighth of an inch thick in one pass. The Western Pipe and Steel people with their clay flux were depositing enough to fill a groove that would weld a half inch plate, and we ourselves found it entirely possible to go to two inches.

Q. Now, the Western Pipe and Steel deposit of which you spoke was subject to the infirmity referred to in Mr. Delhi's letter to Mr. Lester, which has been marked in evidence here as Exhibit 128, I believe.

A. It was a chronic condition.

Q. That, I take it, however, was not true of the one-eighth inch deposited by the coated rod?

A. No. The deposit that resulted from the coated rod was excellent metallurgically. It was handicapped by being a very slow method of depositing metal.

Q. After you had made the experiment that you have detailed on the stand, what if anything did you dis-
168 cover in regard to the immersion of the tip of the rod?

A. We found that immersion was an essential to the operation of the process. We very early suspected immersion, because of the mere fact that we suspected electrolysis, because obviously electrolysis could not take place unless the electrode was immersed.

We made experiments wherein we thinned down the flux and had it so thin that we had an arc of the normal type, and I can conceive of no worse material to use with an open arc or an arc of the usual type than our flux. It produces more holes than any known process, I am sure.

Q. Now, what did you observe if anything as to the need for constancy in the immersion of the tip of the rod?

A. I am just a litt confused at that question.

Q. Did you discover anything in regard to whether the tip of the rod needed constantly to be immersed?

A. Oh, positively. If it comes out momentarily, the damage that is done in the weld might be recovered if it is going slowly enough, but it is a sure invitation to holes of the electrode is not in contact with the liquid flux.

Q. Do you refer to that as the principle of constant
169 immersion?

A. I do.

Q. Turning to the question of speed, the speed at which a given pair of plates could be welded, what if anything did you discover in connection with the experiments in regard to such a speed?

A. Well, we went up to incredible speeds—that is, incredible at the time. My best remembrance is that they were welding half inch plate at about seven or eight inches a minute at Western Pipe and Steel, and we went up to, I think, thirty inches or such values as that.

On light plate we went just as fast as our machine could go, and I think we made something like 54 inches a minute. Anyhow, they were outstandingly large at the time.

Q. That is, you made increases in the speed with which one could weld?

A. Yes.

Q. In the ratio of the figures that you have given in your last answer?

A. Yes.

Q. Will you tell us what if anything you observed after your experiments in connection with the physical prop-
170 erties of the weld that was made by the process disclosed in your patent?

A. Well, we checked with a test bar and we found we had about—oh, I don't know; when we were about flux 40, we were getting what we thought were incredible physical properties. We got, as I remember it, around 64,000 pounds per square inch, and an elongation of 37 and some odd per cent, which was a very high figure at that time. Is the word "elongation" clear?

Q. Will you explain what you mean by the word "elongation"?

A. Well, one of the most valuable properties of metal is ductility; that is, its ability to yield greatly before breaking. Elongation is merely a measure of ductility.

In fact, the breaking of our ships during the war, or any time, was due to lack of ductility. Elongation measures that property.

Q. Now, I want to specifically direct your attention toward a particular flux which, as I understand it, you made as No. 68 of the 75 different fluxes you have testified you made, and I tell you that that flux No. 68 was used in connection with welding test No. 422; and in that connection I want to ask you whether the language referred to in
171 your patent marked in evidence as Exhibit 124, here, appearing on page 2 thereof, lines 50 to 63, refers to

flux Nos. 68 in which you used in connection with welding test No. 422?

The Witness: That describes flux 68.

By Mr. Cahill:

Q. Now, after flux No. 68, what if anything did you add to your flux compositions?

A. We had come to what we thought was a thoroughly satisfactory flux of that caliber, or that type, made of calcium and magnesium, and we then determined to see whether other materials would act as a base.

172 By "acting as a base", I mean that calcium and magnesium are basic materials, metallurgically. Silica is an acid material, and what we had done up to that time was to react a basic and an acid material. Now, then, we decided to find out whether other materials which we knew reacted basically, metallurgically, would function in the same way, so we chose manganese dioxide.

We fused manganese dioxide and silica and welded with it, and I believe our judgment was that it was too penetrating; and then we added calcium fluoride to that, and we made a satisfactory flux of manganese silicate, which established in our minds that manganese would function as a base, as a basic material, in the same manner that calcium and magnesium had.

Mr. Cahill: Just a few more questions.

By Mr. Cahill:

Q. Reverting to your agreement with Western Pipe, earlier this afternoon I understood you to say that it was your agreement and that of Col. Jones and Mr. Rotermund to give Western Pipe a free license.

A. Well, I was—

Q. I wish to ask you whether that was in accordance with your present recollection.

173 A. No. I was confused. We agreed to let them have the first opportunity to acquire the process. I was confused.

Q. Well, what was your agreement with Western Pipe in this connection?

A. There was no formal agreement, because one cannot make an agreement about something that does not exist. At the time we started we had no process, nor did we have any assurance that we would have one. It was just a research project as far as we were concerned.

Q. Was there an understanding?

A. There was an understanding that they would have the first opportunity to acquire the process if such resulted.

Q. Well, after you had made the invention disclosed in your patent, did you thereafter fail to reach an agreement with Western Pipe?

A. We did come to an equitable—at least, what we thought was an equitable agreement, so we departed from Western Pipe.

Q. And you removed to where?

A. To my shop in Albany.

Q. Thereafter did you negatiote with companies other than Western Pipe for the sale of your invention?

174 A. We negotiated with the Union Carbide Research Laboratories, I believe.

Q. Did you reach an agreement with the representatives of that company?

A. We did.

Q. And who was—

A. Mr. Cornwell.

Q. What has been your participation in the royalties which have been received?

A. I know that I will put myself in a somewhat ridiculous position by not being too clear on it, because I am not as mercenary as perhaps I might be, but it has been shown to us that we got $1,200,000.

Q. It has been split how between Col. Jones and Mr. Rotermund and yourself?

A. It has been split equally. We share the work equally and we share the results.

175 Q. Mr. Kennedy, will you explain to us the setup employed in hand welding with the bare rod which is mentioned in your writing on the first page of your patent, and I first hand to you this object which I would like you to identify for the record.

A. This is an electrode holder. Its purpose is to hold the electrode, with which the welder manipulates the electrode and to make electrical contact to the electrode.

Entering here (indicating) is a flexible cable which is connected to one pole of the electric generator. The other pole of the generator is connected to the work to be welded.

Q. When you say "entering here", that would mean

nothing on the record. You are indicating thereby the stem?

A. The cable enters this hole in the electrode holder.

Q. And what does the man who is doing the hand welding wear on his hands?

A. He wears gloves, and he wears a helmet which shields him from the acitinic rays, because I can conceive of
176 nothing that is more painful than an arc burn.

Mr. Cahill: I should like to offer that hand welding instrument in evidence.

Mr. Van Duzer: No objection. Is it one of the plaintiff's manufacture?

Mr. Cahill: No, I don't think so. Reading from the box from which I took it, it is a Duro.

Mr. Van Duzer: Is there any designation there?

Mr. Cahill: Yes. Why don't you look at it?

Mr. Van Duzer: Duro insulated holder No. 3001.

Mr. Cahill: Let the record show that it is a Duro Insulated holder No. 3001. This is Exhibit 129.

While we are doing this marking, I would like to mark a few samples of bare rods and offer them in evidence, and I will offer at the same time a few samples of coated rods.

By Mr. Cahill:

Q. These are samples of bare and coated rods respectively?

A. They are.

Mr. Van Duzer: Whose manufacture are they?

177 By Mr. Cahil:

Q. Whose manufacture are they, do you know, Mr. Kennedy?

A. I do not.

Mr. Cahill: May I inquire?

(Mr. Cahill confers with co-counsel.)

Mr. Cahill: They are GE, in each case. The bare rod is GE type L; the coated rod, GE W-24.

Mr. Van Duzer: I take it these are not going to be used in the actual welding demonstration you are proposing, but are just like pictures, for the purpose of demonstrating what the rod looks like.

Mr. Cahill: These are for the record in this case. The ones I handed to counsel, being rods of the same manufacture and type, will be used in the demonstration.

Mr. Van Duzer: These are not to be used in the actual welding?

Mr. Cahill: No. These are for the purpose of the record, but similar ones will be used in the demonstration.

May we put a tag on them, your Honor?

The Court: Yes.

Mr. Cahill: We will mark the bare rod samples as 178 Exhibit 130, the coated as Exhibit 131.

The Court: All three exhibits are admitted. Did you offer them?

Mr. Cahill: I did offer them, your Honor.

Mr. Van Duzer: We understand they are purely illustrative.

Mr. Cahill: That is right.

Mr. Van Duzer: No evidentiary value, beyond the fact that one is a bare wire and the other is the covered?

Mr. Cahill: That is the condition under which they are offered.

The Court: They may be admitted.

(Thereupon the said articles marked PLAINTIFF'S EXHIBITS 129, 130 and 131 were received in evidence.)

By Mr. Cahill:

Q. Taking the bare rods, Plaintiff's Exhibit 130, and extracting one of them, and taking the holder, Plaintiff's Exhibit 129, will you continue your demonstration of hand welding with the bare rod

A. The electrode is inserted in the holder and supported by the holder, and an electrical connection is made 179 through these copper jaws.

In the meantime, as I explained before, one pole of the generator is connected to the work and the other pole connected to the holder, and the welder manipulates it by contacting the work, at which time the current from the welding machine flows through the connection and, if the welder is skillful, he retracts it slightly and it establishes the welding arc.

The bare electrode, as the arc burns, globules of metal form on the end of the rod, and when they get sufficiently sizable they contact the plate and short-circuit the machine.

In other words, the arc is extinguished momentarily. The drop is detached from the end and causes a part of the weld.

It is a very simple process, but the metal produced under these circumstances is so brittle as to be utterly useless

for any practical purpose, so it has been superseded by other means.

Q. Now, will you tell us briefly again, illustratively, the principle of the art of hand welding, using instead a coated rod, one of which I hand you from Plaintiff's Exhibit 131.

A. The coated rod is handled in exactly the same
180 way. The coating of the metallic rod is probably one of the great advances of the welding industry, because not only the rate of deposition is increased but the quality of the metal produced is excellent.

Essentially everything is the same with a coated rod as it is with the bare rod, as far as manipulation is concerned.

Mr. Cahill: Now, I will ask that this large piece of apparatus here be given a mark of identification. That will be Plaintiff's Exhibit 132.

(Thereupon said article was marked Plaintiff's Exhibit 132 for identification.)

By Mr. Cahill:

Q. I will ask the witness to identify Plaintiff's Exhibit 132.

181 Q. Will you identify briefly that apparatus?

A. That is a Unionmelt welding apparatus.

Q. And the so-called welding head, is it not?

A. Yes.

Q. And I believe Mr. Byron gave the type, Type U, that is correct, is it not?

A. Yes.

182 Q. Will you describe for us the automatic welding process which you call the clay flux process, which you saw the Western pipe illustrating, with the head marked Plaintiff's Exhibit 132 for identification?

A. Well, even before the clay flux process, there was a natural inclination to want to use a continuous electrode, because the stops and starts in these short electrodes prevented mechanization. Very early in the industry, machines were developed whereby the electrode was coiled, and pulled off of the reel by means of a pair of rolls driven with a motor.

Now, it was also necessary to include some sort of a monitoring device, that would cause the motor to feed the wire at the right rate; and so essentially, every welding machine—every automatic welding machine, has this element about it.

Welding machines proved feasible for bare wire feeding, and feasible for the clay process, would be, and
183 were, used in the development of our process.

Now I believe that essentially describes an automatic welding machine. The machine itself merely supplies the electrode, the rod, at a controlled rate.

Now the process—

By Mr. Cahill:

Q. When you refer to the electrode there, you simply mean the rod, do you not?

A. The rod, yes.

Q. Yes.

A. The process in which it is used, made a bare arc in which case you have exactly the same thing as though you had a hand welding process, where the metal is of no better quality, but is exactly the same.

Unfortunately, the automatic machine was not applicable to the flux-covered rod, because the rod was covered with an insulating material, which would be just as though you tried to run a trolley car having an insulated trolley; you just could not make the contact.

Q. When you speak of the "flux-covered rod," there again you mean the coated rod, do you?

184 A. The coated rod, yes, sir. Unfortunately, I omitted one very essential element of this automatic machine, and that is a pair of contacting jaws, with which the electrode makes continuous contact.

The automatic machine, as I have just now pointed out, may be used in any of the processes except the coated rod process.

Now, as applied to the clay process—

Q. That being the process that you saw out at Western Pipe?

A. That was the process of feeding the wire along a seam that was covered with clay. That resulted in an arc which was surrounded by gases, produced by the clay, and the chemical reactions that ensued, and the weld metal that was deposited was covered by a thin layer of the fused clay.

That was the process that I saw out at Western Pipe.

Q. What did you see as to the intensity of the flame in the clay process?

A. Well, it was so vigorous that it looked like it was a combustion process under there.

Q. Now, one additional question, Mr. Kennedy. Will you please describe to the Court the set up for the practice of the process disclosed in your invention.

185 A. Well, again, the same automatic machine that was common to the other two processes, is common to our process.

The fundamental difference, however, is that the end of the electrode is in contact with the conductive material, and is constantly in contact with that material, and the metal is deposited through the conductive material in which the electrode is immersed.

Q. In addition to the other different features, such as greater speed, and higher current, and the like, which you mentioned in your earlier description of the tests at the factory, at Western Pipe; is that not true?

A. I am very sorry, but I do not believe I just understand that question.

Mr. Cahill: The Court Reporter will read the question, please.

(The question was read by the Reporter as above recorded.)

The Witness: I am sorry, but I still do not get it.

Mr. Cahill: My question is directed to the practice of the invention disclosed in your patent; and I am sim-

186 ply making clear that you had not previously covered in detail the differing features in your invention over the prior art.

A. Well, the essential difference is that the end of the electrode is constantly immersed in the flux, and while the electrode was covered by the flux at Western Pipe, it was perfectly obvious that the end of the electrode could be seen, and the bare arc could be seen, because it blew a hole in it.

It was just as though it was—well, the gas which was being produced constantly blew a cave, like, you might say, and the whole operation took place in a cave, which was constantly advancing, because the electrode was advancing, and so in effect the welding operation was shielded by a gas which was produced by the reaction involved in the clay.

By Mr. Cahill:

Q. So much for the process itself disclosed in your invention; but, in addition, your compositional flux has

differing features, which you described in your earlier testimony in regard to it, has it not?

A. Very decidedly.

Q. Now just one or two further questions, Mr. Kennedy.

187 Do you have any familiarity with the process for electric automatic welding as sold by the Linde Company, the plaintiff in this action?

A. Yes.

Q. Can you tell us, how does that process compare with the invention disclosed in your patent?

188 The Witness: The Linde Company's process is practiced identically as our own patent teaches.

203 Mr. Cahill: May it please the Court, I will suspend
204 further examination of this witness at this time, until after the demonstration.

I will withdraw my objection to his being cross-examined at this time, upon the direct examination that I have thus far conducted of him.

The Court: Very well.

Mr. Stewart: May it please the Court.

The Court: Mr. Stewart.

Mr. Cahill: Pardon me just a moment, please, Mr. Stewart. I will have of course, your Honor, some further direct examination of the witness, after the demonstration has taken place, which I am reserving at this time.

Cross-Examination by Mr. Stewart.

Q. Mr. Kennedy, I believe you testified yesterday that you had been notified that you had been awarded a medal from the Lincoln Electric Company for an article which you wrote in the Welding Journal; is that correct?

A. I don't think that I testified that I was notified of an award from the Lincoln Electric Company, no,
205 sir. I was notified by the American Welding Society that I was to receive a medal, which I think is from a Foundation, sponsored by Mr. Lincoln.

Q. Now incidentally, Mr. Kennedy, it is eighteen karat gold. You were curious about that yesterday, I believe.

You testified that in your shop in San Francisco you had all kinds of equipment for making many mechanical tests and experiments.

Did you have the same quantity and diversity of equipment back in 1932 as you have at the present time?

A. I did not testify that my shop was in San Francisco. I testified that—

Q. In Berkeley?

A. —it was in Albany.

206 Q. Well, that is in the San Francisco area, is it not?

A. I have more equipment at the present time than I had at that time, but I had adequate equipment then.

Q. Well, going back to 1932, what welding equipment did you have in your shop at that time?

A. In 1933—

Q. My question was, 1932.

A. In 1932 I had no welding equipment, with the exception of one motor generator.

Q. You had no equipment in your shop with which you could weld by the process taught in the patent in suit, in 1932; is that correct?

A. No, sir, that is not correct. We did have equipment, by which we could weld, but we did not weld with it, however.

207 Q. Did you have an automatic head?

A. Yes, we did. We had built it.

Q. When did you build it?

A. Before we ever went to Western Pipe & Steel.

Q. Did you have an automatic head and generator that would produce sufficient current to demonstrate your so-called process?

A. We did.

Q. When was the first time you had that?

A. Oh, I think it was about two years prior to our working at Western Pipe & Steel.

Q. When did you first demonstrate your process to Mr. Cornwell of the Linde Air Products Company, or any other representative from that organization?

A. I think that was demonstrated in 1933.

Q. Do you remember what month?

A. No, I do not.

Q. Don't you recall, as a matter of fact, that you did not have equipment in your shop that could be used to demonstrate this process before May or June of 1933?

A. We built the equipment with which to demonstrate this process, and did demonstrate it with the equipment that we built.

208 You had asked me previously if we had an au[illegible]matic head capable of demonstrating this welding [illegible]rocess,

to which I answered that we did have such a head, because we had built an automatic head, having for its main objective the use of magnetic wheels with which to hold it on a plate as it moved along; and we used it primarily in bare wire welding, but it could have been used with our flux.

Q. But you never did?

A. I testified we did not.

Q. You did not use it—

A. No, we did not use it.

Q. (Continuing) —to demonstrate your process prior to May or June of 1933, is that right?

A. We never used it.

Q. You never used it?

A. We never used it. I merely stated it was capable and we could have used it, but we didn't. It would have been used on a relatively small scale, because it was a relatively small piece of equipment, compared with that instrument there. It was about eighteen inches long.

Mr. Cahill: Referring to Plaintiff's Exhibit 132 for identification.

209 By Mr. Stewart:

Q. Going back to Western Pipe's process or method of automatic electric welding, how many automatic heads did they have in their San Francisco plant when you made your visits to it?

A. Each welding stall had two heads. In other words, each welding head welded one-half the length. The two heads started simultaneously, one at one end and the other in the center of the pipe, and my best remembrance is that there were two welding stalls, which would mean that there were four welding heads. I think some other place in the plant with which we did not especially concern ourselves had another welding head.

Q. Do you know how many similar heads Western Pipe & Steel Company had in their Los Angeles plant?

A. I was never in their Los Angeles plant.

Q. Didn't you hear at that time of the pipe line welded by this method in Los Angeles?

A. I knew that a welding process was going on in Los Angeles, and I knew by hearsay from Mr. Delhi that in the Los Angeles plant the pipe moved with respect to the welding head; that is, the welding head was stationary

and the pipe moved. In the San Francisco plant the
210 welding head moved and the pipe was stationary. But I never saw any operation in Los Angeles.

Q. When you were called into the Western Pipe & Steel plant in San Francisco, were they then in the process of welding, at that time, sections for a pipe line?

A. They were.

Q. And that was known as the Hetch-Hetchy project?

A. That is true.

Q. What size pipe, both as to diameter and plate thickness, was that?

A. I think the thickness was seven-sixteenths or a half an inch; and my best remembrance of the diameter was about 48 inches, but I could be wrong by considerable.

Q. To the best of your knowledge that line was
211 completed in that plant?

A. It was.

Q. Now, this particular process as you described it yesterday consisted of having a layer, I believe you called it, of clay flux over the seam to be welded?

A. That is correct.

Q. Using an automatic General Electric welding head?

A. That is true.

Q. And feeding the bare wire electrode by automatic means down into that layer of flux?

A. That is correct.

Q. And an electric arc was struck between the electrode and the plate, is that correct?

A. That is true.

Q. How deep was the layer of flux?

A. I imagine it was about two inches.

Q. Did it vary according to who was operating it?

A. No, it did not, because they had a method of leveling it which consisted in drawing a straight edge across the side containers, very much as a man levels a cement sidewalk, so I would say that the thickness was constant.

212 Q. You say that there was a great deal of sparking and flashing, and evidence of an electric arc?

A. There was a great deal.

Q. At any time while you were there, did you completely submerge that arc in the flux, in the clay flux, or did you see it done?

A. We did practically no work on the process. It was covered—the electrode was completely covered when the

operation began, but the violence of the gas omission blew the clay off of it, so that if you looked down, there was a cavity being blown around the electrode, which made it perfectly obvious that you could see the end of the electrode.

Q. You could see the end of the electrode?

A. You could see the end of the electrode, yes, sir.

Q. Where would you have to be, to see the end of the electrode?

A. You could look down at an angle—that is, of course, if you looked down at an angle, you could see the end of the electrode.

Q. You could not see the end of the electrode from the side, because there were confining walls for the flux, were there not?

A. Yes, sir, that is true, but there was a slot
213 through which the electrode travelled, and if you looked at an angle of about 45 degrees, you could see the end of the electrode.

It was something that,—as the flux caved in, it might be obscured momentarily, but there was no question about being able to see it.

Q. Well, as to whether the flux—or the arc was obscured or not depended upon whether the flux enclosed it, or got completely around it, is that not right?

A. It never enclosed it, no, sir.

Q. It never enclosed it?

A. No, sir. That is, by "enclosed", I am defining "enclosed" by having the flux in contact with the rod. There was always an orifice through which you could see.

Q. What kind of goggles, or shields, or anything else, did the employees, the welders, use at Western Pipe at that time?

A. They had—there was available a hand shield, which was a part of the equipment, and whenever a welder who was running the automatic machine wanted to look down, he took that shield in his hand, and looked at it, looked
214 through the hole that the electrode went through.

There was a considerable hole, or annular space around the electrode, through which you could see the arc, and they did see it, and they used the hand shield to observe it with.

Q. But it is a fact, is it not, that there were times when the arc was wholly submerged?

A. I would say, wholly obscured.

215 Q. Is there any difference in your mind between submerged arc or an obscured condition?

A. Yes, considerable. Submerging involves a liquid, to me. This was obscured.

Q. You are familiar with the general term submerged arc-welding in the trade?

A. I know it is used. I don't know what it means.

Q. It couldn't mean that the end of the electrode is submerged in the flux, could it?

A. It doesn't mean that to me.

Q. What does it mean?

A. It means submerged in the liquid.

Q. How deep?

A. The depth of the liquid is not a factor, I think. I think one might be submerged in two feet of water or it might be submerged in 100 feet.

Q. Referring back to the Western Pipe plant, you could pile enough flux on top of it so that the arc could not be seen?

A. I am perfectly certain that that might be the case.

Q. But even so, if you look parallel downward, parallel to the rod and downward, you could see the arc, is that right?

A. Now, you made the statement it could be cov-
216 ered. Now, it might have taken six inches or a foot to do it. I would say no covering I saw at Western Pipe and Steel prevented observation of the arc.

Q. Now, the weld produced by this—you call it "clay flux process," I believe you testified had a characteristic peanut shell finish. What did you mean by that?

A. Well, I find it difficult to describe the term. I can tell you more or less what it came from.

The flux, when you lifted it off, was full of holes about like you might find in cheese, and the texture of the metal was different where it was in contact with the flux and where it was in contact with the hole, and gave a mottled appearance to the weld. That is what I meant by the peanut effect.

Q. By mottled, it looked like the outer surface of a peanut shell, is that right?

A. That might not be a good description, but it was the best we could do.

Q. Have sort of ridges and depressions, some sort of a pattern?

A. I think that might explain it. Some sort of ornamental glass has what we call a peanut effect.

217 Q. You would recognize that type of surface on a weld if you saw it, would you not?

A. I think I would, yes.

Q. Do you know of any other flux that produces that type of finish?

A. Well, I have never seen—under certain circumstances we have been able to produce that ourselves.

Q. When you simulate the same type of flux?

A. Yes.

Q. (Continued.) As the clay flux, is that right?

A. Yes.

Q. So in your opinion it would be a characteristic of the use of that type of flux?

A. If my memory serves me right, we have been able to do it sometimes with our own flux.

Q. Now, when you started out in your experimentation, you testified I believe, that you concluded that it wouldn't prove anything to duplicate the efforts that Western Pipe had made in varying the terms of the voltage or speed of travel in their process, is that right?

A. I didn't say it wouldn't prove anything. I didn't think it was a very fruitful field for research, because
218 we had only three variables, that is, current and voltage and rate of travel, and I assumed that that field would be thoroughly exhausted by the efforts of those that had preceded us.

Q. Regardless of the terminology, you concluded that the field of experimentation which might achieve results was in the flux, is that right, variations in the flux?

A. We concluded that the trouble with the process, as we saw it, was the evolution of enormous quantities of gas in the welding zone.

Q. You were at that time familiar with the coated welding rod, were you not?

A. We were familiar with it, yes. It was not universally used at Western Pipe and Steel. They did a lot of bare wire welding, but we were familiar with the coated rod at the time.

Q. You had welded with heavily coated rods at that time, had you not?

A. We had not.

Q. You had not?

A. No. Our—

Q. Had you seen it done?

Mr. Cahill: May he finish his answer, please?

219 Mr. Stewart: Yes. Go ahead.

The Witness: Our own experience was limited to bare wire welding, but we had seen and as a matter of fact our assistants at Western Pipe and Steel always used a coated rod to tack the plates together.

That is, in automatic welding it is necessary to tack the plates in their relative positions in which they will be welded in order to hold them together during the operation, and they always used a coated rod in doing that.

By Mr. Stewart:

Q. You had seen that done?

A. Yes.

Q. When that was being done, were there large quantities of gas being exuded from the welding zone?

A. I would say there was a great deal of smoke emanating from the welding operation, yes.

Q. Yet the welds produced were not porous but were good solid metal?

A. Well, there was this characteristic about them.

220 In many of our trials we had a perfect weld except where it went over a tack, and when it went over a tack, we had holes, so much so that we investigated the whole subject by making a weld with a plate that was all tack.

So I cannot speak for the quality of the metal that was being deposited at that time, but at least I do know this, that it was a fruitful source of holes in fluxes that showed no holes except where it went over a tack.

Q. You do not know whether the holes were already in the hand weld or not, do you?

A. I assume that the gases that produced the holes must have come from the tack.

Q. What does produce a hole in a weld?

A. Well, I would say that when the metal congeals and entraps gas in the weld, you would have a hole.

Q. What kind of gas?

A. Well, I do not know that I am prepared to say what kind of gas. That is, it might be carbon monoxide, it might be carbon dioxide or it might be nitrogen.

Q. Is it not primarily a fact that carbon in steel com-

bines with oxygen and makes carbon monoxide or car-
221 bon dioxide?

A. That is an entirely possible chemical reaction.

222 Q. Is that not the normal thing, that you try to avoid in welding?

A. Do you mean, the formation of carbon monoxide?

Q. Yes, because of the presence of carbon in the steel, and oxygen in the air, if you do not properly shield them.

A. It is a reaction which you like to avoid, because the loss of carbon may be a serious factor in the strength of the weld.

Q. And is that not what porosity comes from, in welding?

A. I would say that that was—or might be one of the sources of porosity; and the nitrogen is equally possible as another source.

Q. Now, you have stated that you think that there may have been holes in the hand welding which was done at Western Pipe.

You are familiar, however, are you not, with coated electrodes today that will make a weld without any pin holes in it?

A. There has been an enormous improvement in the electrodes; it has been astounding.

Q. And such coated electrodes, when used, give off large quantities of gas, do they not?

223 A. That is true.

Q. Because they have in their coating very often combustible material?

Q. Is that correct?

A. Yes.

Q. And yet, with all that quantity of gases, you get no holes in the welds; is that correct?

Mr. Cahill: You are still speaking as of today, I take it.

Mr. Stewart: Yes.

A. That is correct, yes, sir.

By Mr. Stewart:

Q. What is the purpose of a coating on hand electrodes —or, on electrodes for hand welding?

224 A. To improve the quality of the metal that is deposited.

Q. How does it do that?

A. By protecting the deposited metal from contact with the oxygen and nitrogen of the air.

Q. It shields it, does it not?

A. That is true.

Q. It protects not only the zone where the weld is taking place, but also lays down a layer of slag on top of the molten metal?

A. That is true, but a much more—or rather, a much less viscous slag than was laid down at Western Pipe & Steel.

That is, after all, the opportunity for the escape of the gas is infinitely better in the case of the coated rod of today, than it was at Western Pipe & Steel; and furthermore, at Western Pipe & Steel, they were laying down a layer one-half inch thick.

Q. A layer of what?

A. A layer of metal one-half inch thick, at one pass, from which the opportunity of relieving itself of the gas was much less than it is with the coated rod at the present time, with a one-eighth inch layer.

225 Q. That depends upon the ingredients that are used in the flux, does it not, as to whether you have a good layer of slag or not?

A. How is that?

Q. I say, it depends on the ingredients used in the flux, as to whether you get a proper operating layer of slag, or not.

A. Do you mean, the flux or coated rods, or—

Q. Or in the deep flux welding, either one.

A. The components of the flux are of course important to both, the coated rod, and to our process, and to your process.

Q. And it is important, is it not, to have the melting point of the flux lower than the melting point of the steel?

A. I would say that that was true, yes, sir.

Q. Is that not essential?

A. I think so, yes.

Q. And the reason for that is, is it not, that unless your flux stays molten after your steel chills, your gases cannot get out?

A. Well, if the steel has congealed, the damage has been done. The gas must escape while the steel is a liquid.

226 Q. It cannot escape if the flux has already solidified, can it?

A. Well, I do not know. There is less opportunity; but it is possible—as a matter of fact, the gas comes out of the metal, and if the flux is viscous—there is no definite

melting point; it is a little bit like glass—so long as the gas has enough energy to escape from the metal, it may escape; but in general, I would agree with what you said, yes, sir.

Q. You have in your experimentation used fluxes that have too high a melting point, have you not?

A. We have.

Q. They do not make very good welds, do they?

A. Magnesium oxide was not useful.

Q. I believe yesterday you testified that you first decided to try a method of preparing the flux which would avoid gases being generated in the welding operation.

A. That was our objective.

Q. And in order to do that, you used cupola slag?

A. That is correct.

Q. The reason for that was that the slag has already been chemically reacted?

227 A. That was one of the reasons.

Q. In the heating operation of the cupola?

A. Yes.

Q. Were you not familiar with the use of slags as welding fluxes years before that?

A. I had never heard of any welding fluxes in electric welding—

Q. You had never heard—

Mr. Cahill: Let the witness finish his answer, please.

A. (Continuing.) Our experience in electric welding had been limited to bare wire welding, and we know nothing whatever about electric welding fluxes.

By Mr. Stewart:

Q. So that you knew nothing about the use of blast furnace slag, open hearth furnace slag, asbestos, or any number of silicates that had been used up until that time; you knew nothing about them?

A. We knew nothing about them; and furthermore our experience with such slags was that they were not suitable.

228 Q. Now, the cupola slag that you used, I believe you said yesterday, had calcium silicate in it?

A. Yes.

Q. A major portion of calcium silicate?

A. We knew it contained alumina, and we also knew it contained impurities, we didn't want.

Q. But it contained a major portion of calcium silicate; did it not?

A. That was an assumption on my part. We knew it contained calcium oxide and silica and aluminum oxide. Those we were sure of. It might have contained phosphorus.

Q. Did you analyze it?

A. No, we did not.

Q. But it didn't work very well as a flux, is that right?

A. Yes, it did. It worked well. It was not an ideal flux, as far as we could see, because we knew that—we certainly hoped for a better result; but it worked quite well, yes.

Q. Have any pin holes?

A. Yes.

Q. Even though it was a pre-fused flux, it did not give off any gas in the welding operation?

A. There were other elements present that we were
229 later to learn of that were sources of gas.

Q. The alumina?

A. No, there was iron oxide.

Q. Did you ever try, in your experimentation, iron silicates?

A. Yes, we did. We made them.

Q. Were they successful fluxes?

A. Well, success is a relative term.

Q. Did they produce a good weld?

A. I don't remember exactly the quality of the weld they made. The fact that we just made one batch and made some welds with it and decided against it, and decided to do something else, is reasonable evidence that we weren't satisfied with the result; but in most every case we welded.

Q. You could weld without any flux, is the answer to that, isn't it?

A. No, I wouldn't say so. I would say we were probably using eight or nine hundred amperes on it. I would just say it didn't seem to us to be something that would be productive of as good a result as some of the other fluxes.

Q. You recall, Mr. Kennedy, when your deposition was taken in San Francisco last July?

A. Yes, I do.

230 Q. And Mr. Jones' and Mr. Rotermund's at the same time?

A. Yes, sir.

Q. You were all in the room when each of you testified?
A. I remember.
Q. Do you remember Mr. Jones being asked where his papers, notes and other written matter relating to your experiments were at that time?
A. I don't remember, no.
Q. Do you recall any questions being asked at that time as to where your experimental notes were?
A. No, I can't say that I remember.
Q. Where were they?
A. Our experimental notes?
Q. Yes.
A. In my pocket.
Q. In your pocket?
A. In my pocket. While I was testifying—I mean while you were taking my deposition, they were projecting out of my pocket.

231 Q. Mr. Kennedy, those notes consisted of a series of welding tests and a series of flux compositions numbered in sequence, did they not?
A. In general, the first part of your question I agree with; the sequence, as best we could assemble the pages. The notebook had become disarranged and the sequence is the best that we could make of it.
Q. To put it perhaps more clearly, however the pages are now arranged, you had welding tests listed begin-
232 ning with the number 1 and ending up close to 500?
A. That is correct.
Q. If you got the pages in their right order, the tests would follow in numerical order according to those numbers, is that correct?
A. Well, we were not quite so orderly as that. It does not necessarily mean that the tests conformed in sequence. Jones kept the notes, and I think he did a fair job in trying to keep them in some sort of order, but I would not like to commit ourselves and say positively that this test followed that test.
Mr. Stewart: Do you have the original notebook there?
233 Mr. Stewart: All right. I will ask that it be marked Defendants' Exhibit 88.

(Said document was marked Defendants' Exhibit No. 88, for identification.)

By Mr. Stewart:

Q. Handing you again what has been marked Defendants' Exhibit 88, is that the original set of notes covering your experimentation?

A. Those are the original set of notes.

Q. In connection with the patent which was eventually granted bearing No. 2,043,960?

A. Yes.

Q. Will you examine those notes and confirm the statement that they do contain welding tests numbered in sequence, various combinations of ingredients for fluxes numbered in sequence and other notes?

234 A. I will agree to everything except the sequence. As you can see, the notes were detached, and we tried our best to put them back in their proper order, but to all intents and purposes these are the notes that were made in the handwriting, principally, of Jones, very little in my handwriting and just a little little in Rotermund's.

Q. Does that set of notes cover the entire written record of your experimentation in the year 1932 at the Western Pipe Company?

A. As far as I know it does. Rotermund may have written something. I do not know. I am quite sure I did not.

Q. At that time, during all the time you worked at the Western Pipe Company plant, you believed you had an electric arc-welding process, did you not?

A. It was a matter of debate between the three of us as to how the process worked.

Q. There is not—

Mr. Cahill: May he finish please?

The Witness: At one time maybe one of us would say, "Well, maybe it is not an arc," and so forth. We were in doubt at that time.

By Mr. Stewart:

Q. There is not one note or indication in that set
235 of experimental notes, Defendants' Exhibit 88, which shows any such doubt, is there?

A. To use the word "arc" implied—

Q. My question can be answered "Yes" or "No."

A. As far as I know there is no mention in these notes of anything that would imply what our process was.

Q. There are, however, in that set of notes repeated references to "arc" and "arc control"?

A. That is true.

Q. And you offered the Western Pipe and Steel Company a contract for—a proposed contract for the exploitation of what you believed was your invention, you described your process as an arc process, did you not?

236 A. I do not know that we did. We may have.

Q. I hand you a photostat entitled "Articles of Agreement" and ask you to identify it.

(Handing document to the witness.)

Can you identify that?

A. I see that my name and Jones' and Rotermund's are in here, but as far as I am concerned I am unfamiliar with it.

Q. You have never seen the original of that before?

A. Not to my knowledge, no.

Q. You heard Mr. Jones identify it when his deposition was taken at San Francisco, did you not?

Q. You did hear him, did you not—Mr. Jones— identify that when his deposition was taken?

A. I do not know, no. I do not know that he did.

237 This document—I see my name here, but I do not remember the document. I don't deny it. I just do not remember it.

Q. You do recall, do you not, Mr. Kennedy, that you attempted to negotiate some arrangement with Western Pipe & Steel for the exploitation of what you believed was your invention?

A. That was true, but I had so little to do with the negotiations, any negotiations that were—well, practically all of them were with Jones, so I had little to do with it.

Q. So far as you know, that may have been prepared by Mr. Jones, is that right?

A. It might have been.

Mr. Van Duzer: Well, will Mr. Cahill admit it?

Mr. Cahill: I may state, your Honor, that Col. Jones is in court, and I intend to call him as the next witness and go into this with him.

Mr. Van Duzer: You know it is the proposed contract, do you not?

Mr. Cahill: As far as I am concerned, I am per-

238 fectly willing to concede that, but I cannot concede this man knew anything about it because my belief is

that Col. Jones handled it. As to the authenticity of the document, there is no question.

Mr. Stewart: There is no question about that?

Mr. Cahill: No.

Mr. Stewart: I offer it in evidence as Defendant's Exhibit 89.

The Court: Is there any objection?

Mr. Cahill: No objection.

The Court: It may be admitted.

(Thereupon said document was marked DEFENDANT'S EXHIBIT 89 and received in evidence.)

By Mr. Stewart:

Q. Mr. Kennedy, calling your attention to page 2 of Defendant's Exhibit 89, will you read the first three paragraphs.

A. Aloud?

Q. Yes, if you will.

A. (Reading.) "Whereas said development has been successfully completed to the extent that it has for
239 several months been of such commercial value that it is capable of welding at a single pass steel plates of the order of one-inch thickness and double this thickness when using the two-pass method and

"Whereas weld metal deposited by this method is seemingly perfect in homogeneity, in density; possesses the requisite tensile strength and ductility and metallurgical properties and

"Whereas said metal is deposited by the use of an alternating current arc and by the use of a flux by means of which the amount of the penetration may be controlled."

Q. In describing the development made by you three men in that proposed agreement, you have read, have you not, the metal is deposited by an alternating current arc?

A. The word "arc" to us did not necessarily imply how our process works, any more than to say that an electric lamp burns implies there is combustion in the filament.

Mr. Stewart: Will you please answer the question?

240 A. That is correct, and we frequently describe our process today as an arc.

By Mr. Stewart:

Q. I believe you testified yesterday that you prepared the first application for the patent.

A. The preamble to the application.

Q. Not the claims?
A. Not the claims.
Q. By the preamble, you mean the specifications?
A. That is correct.
Mr. Stewart: That I believe has been offered as Plaintiff's Exhibit 126.
Mr. Mason: 125.
241 Q. Mr. Kennedy, in electric welding that was done at the Western Pipe Company, I believe you said that there was an electric arc present; is that right?
A. Yes, there was.
Q. At Western Pipe?
A. Yes.
Q. In hand welding with bare or coated electrodes, there is an electric arc present, is there not?
A. That is true.
Q. How do you define an electric arc, as used in electric welding?
A. Well, an electric arc, as used in welding, is the passage of a current between an electrode and the work to be welded.
The intervening gas between the electrode and the work is normally an insulator before the arc is struck, and becomes conductive after the arc has been struck, and thereby the current is carried by the ionized gas between the electrode and the work.
242 The heat of the operation melts the electrode and the work.
Q. So that the space between the end of the electrode and the work piece, where the arc exists, is an ionized gas?
A. That is true.
Q. And that is the type of arc in electric welding with which you are familiar?
A. That is true.
Q. That is, at Western Pipe; and in hand welding, in 1932, you were familiar with that type of arc?
A. Yes, sir.
Q. The heat generated in such operation—the heat generated by the arc, that is—is the product of the current times the voltage—I mean, the power is the product of the current times the voltage, is that right?
A. That is generally true, yes, sir. It is not true, however, on alternating current arc.
Q. Well, let us confine it to a direct current arc.

A. That is true, but—

Q. If you are welding with 1,000 amperes, 40 volts, you would produce 40,000 watts or 40 kilowatts, is that correct?

A. That is too general. I would not agree with it. It would not be true on bare wire welding without
243 any flux surrounding the operation, because it consists of a series of short circuits and open, and the average of the voltmeter is not necessarily correct. I would say if you put a wattmeter in there, which is more suitable to measure power, I would agree readily.

Q. If you can maintain a uniform arc length, that would be true, would it not?

A. No, because on an alternating current arc—

Q. I mean, on direct current, Mr. Kennedy.

A. I would say yes.

Q. The number of calories per second in the way of heat which is generated is approximately one-fourth as many calories per second as there are watts of power produced?

A. If that is the conversion factor.

Q. Approximately one-fourth. So that if you generate 40,000 watts per second, 1,000 amperes and 40 volts, you would be generating how many calories per second? Ten thousand calories per second, is that not correct?

A. I do not happen to remember the conversion factor between watts and calories. They are both measures of energy—or of heat.

244 Q. You do not question that conclusion?

A. No, I do not.

Q. That is a great deal of heat produced in a very small space, is it not?

A. That is true.

Q. Do you know the temperature of the electric arc in a gaseous medium that is used in welding?

A. No, I do not.

Q. Have you ever tried to acquaint yourself with tests that have been made to determine that temperature?

A. I have read books that have made statements to the temperature. For instance, there is a statement that the temperature of the arc is equal to the boiling point of the electrode, with which I did not agree, because I found it quite possible to melt metals whose melting point was higher than the boiling point of the electrode, so I did not agree with that statement.

Q. The authorities that you did read or consult with which you may have disagreed, all say, do they not, that the temperature of the electric arc, the welding arc, is at least at boiling point of the electrode?

A. At least at boiling point of the electrode, I
245 would say is probably true; but I didn't even find agreement in the authorities, and I still prefer to take an experiment I make myself, in spite of authorities.

Q. Now, when you were doing your experimentation at the Western Pipe plant, trying different fluxes, I believe you said you first used cupola slag. Was that the first flux used or made by you?

A. We didn't make it. That was the first flux we used.

Q. And that would be in that set of experimental notes as the first one?

A. Designated as Marchant, because it came from a foundry operated by the Marchant Company.

Q. And you found by using that slag ground up as a flux the arc was not visible, is that correct?

A. That was correct.

Q. What particle size did you grind that slag to?

A. We had a grinder available, and we ground it—I can't give an exact measure of the size.

I think some particles came out possibly the size of rock salt. They were variable; there were variable size particles. We made no attempt to separate them.

246 Q. It was a much greater average particle size than the powdered clay used by Western Pipe, is that correct?

A. That is true, it was a larger size.

Q. Did you attach any significance to the difference in particle size, so far as submerging the arc is concerned?

A. We didn't think that was the controlling factor, because after all the enormous evolution of gas wasn't there, and the particle size could not have changed that, nor was there any evidence of an evolution of gas because the flux was no longer full of holes. There was a definite diminution in the gas produced; in fact, there was none produced.

Mr. Stewart: May I have the question read again and have the question answered, your Honor.

Mr. Cahill: I submit he asked for the operation of the witness's mind.

The Court: Read the question.
(The question was read.)
The Witness: I think the answer is "No."

By Mr. Stewart:

247 Q. Was the specific gravity of the ground slag considerably higher than that of the powdered clay used at Western Pipe?

A. I don't know what the specific gravity of the clay was, nor do I know what the specific gravity of the cupola flux was.

We know that cupola flux—or cupola slag, rather, was light enough for the purpose, because it clears itself in the case of cast iron; it floats on top, so that we know that it was right from that angle, although, frankly, we had not gotten to that lesson as yet.

Q. When did you get to the lesson that specific gravity is important in submerging the arc?

A. In submerging the arc?

Q. Yes.

A. I do not think that that factor entered in there. Specific gravity is important in having the flux separate from the metal, and somewhere in the notes, I recall the statement that was made in which we said that our flux must have a low specific gravity, and low melting point; but whether Jones put the statement in the notes, whether that was the time—I think that was a summation of our

248 experiences up to that time; but specific gravity to us meant that the flux must be light enough to separate from the metal, so as not to entrain itself within the metal.

Q. In other words, you did not want it to sink in the molten metal.

A. That is exactly right.

Q. You tried, I believe, as one of your experimental fluxes, silica?

A. We did.

Q. Just sand?

A. Yes.

Q. Were you able to see the arc when you used a layer of sand?

A. On some occasions we could make sand behave as a conductor, but it was very difficult—

Mr. Byron: Let the witness answer the question.

Mr. Cahill: I submit that the witness is answering, your Honor.

The Court: Read the question, please.

(The question was read.)

The Witness: I would say that there were a great deal of pyrotechnics, yes, but we saw the arc.

By Mr. Stewart:

249 Q. All the time?

A. No.

Q. Or only intermittently?

A. Sometimes we could completely submerge it in the sand. It is a long time ago, since we performed that experiment, and I cannot say that I can just be specific as to what we did see at the time.

That was fifteen years ago.

Q. You do know, do you not, that you can submerge the electric arc by using sand as a flux?

A. I do.

Q. And you do not get a very good weld, do you?

A. No, sir, you do not, because its low conductivity means that the weld is about three-sixteenths of an inch wide, and it is about half an inch high, because its conductivity at the temperature is too low.

As a matter of fact, it builds up something like a cockscomb.

Q. And yet it is a pre-fused substance in nature, is it not?

A. Well, nature has made it rather stable.

Q. Nature has pre-fused it, has it not?

Mr. Cahill: May the witness finish his answer, please?

250 The Witness: (Continuing) It is possible to vaporize it.

By Mr. Stewart:

Q. Well, Mr. Kennedy, it is possible to vaporize anything, is it not?

A. It is pretty difficult to vaporize carbon, but that is a generally true statement, yes, sir.

Q. Do you not know the vaporization point of carbon?

A. No, sir, I do not happen to remember it.

Q. You have never had occasion to look that up?

A. Oh, I have known it, but I have forgotten it at the moment; I do not have it at my fingers' ends.

Q. How do you understand—or what is your under-

standing of how carbon arc-welding operates, unless the carbon vaporizes?

A. Oh, I am not denying that carbon vaporizes.

Q. Therefore the carbon arc must be at least as hot as the vaporizing point of the carbon, is that not correct?

A. I think that is true.

Q. I will hand you, Mr. Kennedy, what has been marked Plaintiff's Exhibit 125, which is the File Wrapper of the first application in relation to the patent in suit. I believe you testified that you prepared the specifications, did you not?

251 A. A great deal—yes, I think I prepared the major part of it. I do not think I hold myself responsible for every sentence, but in general I did, yes.

Q. You testified yesterday you had prepared the specifications.

A. I think that is true.

Q. And again this morning.

A. Yes.

Q. Is that right?

A. That is true.

Q. I call your attention to page 1, line 1, in which you state:

"This invention relates to a method of electric arc-welding in deep flux and also to the flux employed."

That was a true statement made by you at that time, was it not?

A. That was true.

Q. That application was filed, was it not, February 21, 1933? Does that not appear, the filing date, on the—well, that is agreed.

In that application on page 2 you described the Western Pipe process, did you not?

A. Yes.

Q. And you described that in this language:

252 "—and the arc is struck, under this powdered flux, the arc being submerged in the fluxing material."

You made that statement?

A. That is true.

Q. On page 3, lines 8 and 9, you made the following statement:

"It is the purpose of this application to deal with a new method designated as submerged arc electric arc welding."

That was the terminology you use to designate your process?

A. That is correct.

Q. In the Claims that were drawn to accompany that specification, in all but two of the 21 of them that
253 word "arc" or "electric arc" is used, is it not?

A. I think that is true.

Q. Now, your attorneys at that time were Messrs. Townsend and Loftus of San Francisco, were they not?

A. That is true.

Q. You were unsuccessful in reaching any agreement with Western Pipe Company about a contract for the exploitation of your invention?

A. That was true.

Q. And that was known to you as early as the 10th of January, 1933, I believe?

A. That is tue.

Q. You testified yesterday that you did successfully negotiate with representatives of the Union Carbide and Carbon Research Laboratories, Inc.?

A. That is true.

Q. Some of the individuals, however, were employed by Linde Air Products Company?

A. That is true.

Q. In those negotiations?

A. That is true.

Q. As a matter of fact, all of your dealings were with Linde Air Products Company representatives in February, March, April and May of 1933, were they not?

254 A. Well, I do not think that I knew the official capacity or the company connections of everybody with whom we talked.

Q. So far as you knew—

A. I did not really know. I know they represented—they were connected with the Union Carbide Corporation.

Q. The principal people with whom you dealt were Mr. R. E. Cornwell, who is here in the court room?

A. That is true.

Q. And Mr. J. B. Hirst who at that time was connected with the Linde Air Products Company in California?

A. That is true.

Q. And in your negotiations with these two gentlemen you described your process, did you not?

A. Well, we did—no. Well, wait a minute. Sometime during the negotiations, yes, but not in the beginning.

255 Q. Well, in April of 1933, you described your process in detail, even though you did not show them the application which was then on file, the patent application?

A. No, we did not describe it in detail. We didn't describe it at all.

Q. You didn't tell them anything about it?

A. No intimation as to how the weld was made.

Q. You didn't tell them in April, particularly Mr. Cornwell?

A. Well, now, I am not going to commit myself to April. I am going to say that on our first discussions with them, in which Mr. Cornwell and Mr. Hirst and the patent attorney for Union Carbide were present, we spent the whole evening discussing the weld, but we did not describe it, did not describe the mechanism of its production.

Q. Well, would this be a true statement, that you did not describe the operation of your process until you had agreed to let them have a copy of the patent application?

A. I don't remember just when we did describe it to them. We certainly did ultimately, but it escapes my memory.

256 I do know that on our first meeting with them we didn't describe the method of its operation; that I know, and when—

Q. You did eventually?

A. Oh, of course.

Q. Did you describe it before you gave them a copy of your first application with the agreement that they would not use it if no agreement was reached?

A. I think that was true. It is rather vague in my memory, but I think that was true.

Q. Did you, in your discussions with them, before you let them see the patent application, tell them substantially the following facts:

"The arc is then started with the standard voltage and amperage, and within a few seconds the automatic travel is placed in operation."

Did you tell them substantially that about your process?

A. I don't know that we did.

Q. Would that be a true statement at that time, in April?

The Witness: Will you read that statement again?

Mr. Stewart: "The arc is then started with the
257 standard voltage and amperage, and within a few seconds the automatic travel is placed in operation."

The Witness: I think that is a true statement.

Mr. Cahill: What are you reading from?

Mr. Stewart: I am reading from what has been marked Defendants' Exhibit 54, Mr. Cornwell's letter to Mr. Critchett.

Mr. Cahill: Will you read the last question and answer, Miss Reporter?

(The record was read.)

By Mr. Stewart:

Q. Did you also tell Mr. Cornwell, in April of 1933, in connection with your process, substantially as follows—and this is on page 1, Mr. Cahill:

"The Vee is then filled with a special flux and extends about ½ inch above the weld and on each side of the Vee."

Would that have been a fair statement at that time?

A. I think it would have been a fair statement.

Q. The flux depth of a half an inch?

A. It depends upon—it would have been a fair statement for some thickness of plate welding.

Mr. Cahill: I think it is fair to make plain to the
258 Court that these do not purport to be statements by the witness. This is a letter by Cornwell to a man named Critchett.

The Court: It will be so understood.

Mr. Cahill: The Court doesn't have the letter before it; it is not offered in evidence.

Mr. Van Duzer: The question is whether or not in their discussions they made such statements.

Mr. Cahill: There is a reading going on, and I didn't want the Court to get the impression that the witness made these statements. They are statements by Cornwell to Critchett.

Mr. Stewart: On page 2, Mr. Cahill, of the same letter.

By Mr. Stewart:

Q. Did you tell Mr. Cornwell, at the same time, that "it is impossible to permit a variation greater than one-quarter inch in the length of the arc, and for this reason a very sensitive automatic head is required"?

A. I might have said that.

Q. You did reach an agreement, after discussions
259 with Mr. Cornwell and Mr. Hirst, under which you gave them a copy of your original patent application, is that right?

A. That is as I remember it, yes.

Q. It is not important, but do you recall that was in May of 1933?

A. I don't know.

Q. One of the claims, Claim number 16, in your original application, found on page 13 of Plaintiff's Exhibit No. 125, reads as follows, does it not:

"A method of electric arc welding in the presence of a flux which consists in substantially enclosing the arc in a flux which has been rendered chemically inactive."

That was one of the claims submitted with your first application, was it not?

A. That is true.

Q. Now shortly after you had reached your agreement to let representatives of Union Carbide have a copy of your application, the Patent Office's first action took place, is that not true?

A. (No answer.)

Q. There had been no action by the Patent Office on your application up until that time, had there?

260 A. I think that there was required a division, by Townsend & Loftus, but I am not claiming to remember it.

Q. Well, I call your attention to page 16 of this same file wrapper, which is the action of the Patent Office requiring a division, is it not?

A. Yes.

Q. And that is dated May 27, 1933?

A. Yes.

Q. That requirement of a division by the Patent Office cited what are called References of Record, in the opening paragraph, did it not?

A. Yes.

Q. And among those References of Record are the following patents:

Whitcomb, No. 277,393, dated May 8, 1893.

Miller, No. 1,748,785, dated February 25, 1930

Vervaet, No. 720,300, dated February 10, 1903; and

Robinoff, et al, No. 1,782,316, dated November 18, 1930.

I have read them correctly, have I not?

A. Yes.

261 Q. You had never heard of the Robinoff patent up until that time, had you? You may answer that question yes or no.

A. Yes, we had heard of it.
Q. Had you read it?
A. Yes.
Q. When?
A. The Robinoff patent was given to us, I believe, by the superintendent of the Western Pipe & Steel Company.
Q. The Patent?
A. I think so.
Q. At that time, had you ever heard of the Miller patent, referred to?
A. I never had heard of the Miller patent, no.
Q. Have you had an opportunity to review it since?
A. No, sir, I have not; I do not know what it pertains to.
Q. During the time between February 21, 1933, and November of 1933, did you conduct any tests in your laboratory designed to determine whether or not your process used an electric arc in a gaseous medium?
A. Yes, we did.
Q. What were those tests?
A. Primarily immersing an electrode in a pot containing fluid flux.
262 An iron pot?
A. An iron pot primarily, yes.
Q. You had not done that before, in that period?
A. We had melted flux over at Western Pipe and Steel in a pot containing flux. We had primarily used the pot, however, as a production means for making flux, and incidentally observed its conductivity. In our use in the laboratory the pot was primarily set up to determine some of the properties of the flux.
Q. The conductivity of the flux in the molten state—any flux—is not an unusual phenomenon, is it?
A. It is a known property of most materials that when they are melted they become ionized and they become conductive. The degree of the conductivity is a variable thing.
Q. The same as some metals are more conductive than others, is that right, in the solid state?
A. That is true of solids, yes, but I do not know of any metal that is an insulator when it is cold and becomes a conductor when it is hot. That is quite a distinction between our flux and a metal.
Q. The Robinoff Patent which you say you had read prior to the time the patent office cited it, called for elec-

tric arc welding under a deep layer of flux did it not?

A. No. My remembrance of the Robinoff Patent was a Vee filled flush with an unknown flux and stressing the virtues or the values of iron oxide in the flux, which was still unknown, because he was under the misapprehension that the iron oxide was magnetic and that in some way it made the welding better. That is all I got out of the Robinoff patent.

Q. That is all you understood from the Robinoff patent?

A. That is all I understood.

Q. Were you under the impression that the process used in the Western Pipe and Steel Company plant was the process taught by the Robinoff patent?

A. No, I was not.

Q. You were not?

A. I do not believe I was. As I understood it, it was a process—it was the National Tube process, and as far as I could see it bore no relation to the Robinoff patent.

Q. You did not connect the two at all?

A. I made this connection, that the superintendent at the Western Pipe and Steel in talking about the National Tube process mentioned Mr. Robinoff in connection with it,
264 but I am referring to what we learned from the patent, which had no relation to what we saw at Western Pipe.

Q. When you finally completed your negotiations for the sale of your invention, an agreement was made with Union Carbide and Carbon Research Laboratories, Inc., was it not?

A. That is true.

Q. In November of 1933. That is right, is it not?

A. I will not question your reading it. I do not know the exact date.

265 Q. Handing you a document which has been previously marked Defendants' Exhibit 8, will you identify that, please?

Mr. Cahill: I will stipulate that that is it. You do not need to take the time of identifying it.

Mr. Stewart: We will offer it in evidence as Plaintiff's Exhibit 90.

Mr. Cahill: No objection.

266 The Court: It may be admitted.

(The document was marked DEFENDANTS' EXHIBIT 90 and admitted in evidence.)

By Mr. Stewart:

Q. As part of this agreement, Mr. Kennedy, you and Messrs. Jones and Rotermund agreed, and I am now reading from page 2, paragraph (D):

"To sign all such applications for Letters Patent so prepared by or for the company and with respect thereto, to the present applications, to make all rightful oaths in connection therewith and with the said inventions and improvements."

You did so agree, did you not?

267 Mr. Cahill: I think, Mr. Stewart, that you inadvertently got the word "thereto" in the wrong place. I think the context reads:

"With respect to the present application, to make all rightful oaths in connection therewith."

The "to" or the "with" does not refer to the signing of such applications for letters patent so prepared by or for the company.

Mr. Stewart: I am quite willing to accept the correction. That is what I get for trying to read it at an angle.

By Mr. Stewart:

Q. Now, yesterday, Mr. Kennedy, you testified that there were some modifications of the application that was prepared by you, modifications made by your attorneys.

A. Yes.

Q. No amendments or modifications were made by Messrs. Townsend & Loftus, were there?

A. Not after the Linde attorneys took the case, no, sir.

Q. But they had made none up until that time, even, had they?

A. I think that is true.

268 The second application was not prepared by you, was it?

A. No.

Q. That was prepared by the Union Carbide patent attorneys, was it not?

A. That is true, yes.

Q. And it was sent out from New York to California for your signature, was it not?

A. Yes.

Q. And there was no mention of an electric arc in that application, was there?

A. No.

Q. The second application prepared by the Union Carbide's lawyers in New York, define the process as a process entirely different from the arc-welding process; is that not correct?

A. Yes.

Q. Was this application sent directly to you by the Union Carbide's patent attorneys, or was it sent to the Linde Air Products Company San Francisco office, and brought out to you?

269 A. That was the procedure, yes.

Q. Did you see the covering letter that came with it?

A. Why, I probably did, yes, sir, but I do not remember it at this time.

Q. That was the first time in that application and that covering letter, that the term "conductive melt" was used, in that patent application, or in proceedings before the Patent Office; that is correct, is it not?

A. That is true.

Q. And the term "conductive melt" was used throughout the application, instead of the word "flux", was it not?

A. That is true.

Q. You had not thought of that phrase, "conductive melt", had you? That had been suggested from New York, is that not correct?

A. We had not coined the phrase, no, sir, but we had coined the idea.

Q. You had not coined the phrase, was my question.

A. No, not the phrase.

272 Q. Mr. Kennedy, this morning I asked you if you had ever heard of the Robinoff patent prior to the time the Patent Office cited it, and you said you had.

A. That is true.

Q. You said you had read it; you said it was given to you by the superintendent of Western Pipe.

A. That was the way I remembered it.

Q. What was it you said was your understanding of the teachings of the Robinoff Patent as you read it?

A. I said, I did not associate the information contained in the Robinoff Patent, with the process that we observed at Western Pipe and Steel.

Q. I believe—and I am quoting from your testimony this morning—at page 263 of the transcript you said, in answer to my question—well, first, my question was:

"Q. The Robinoff Patent, which you say you had read

prior to the time the Patent Office cited it, called for electric arc-welding under a deep layer of flux, did it not?"

And then your answer was:

273 "A. No. My remembrance of the Robinoff Patent was a Vee filled flush with an unknown flux and stressing the virtues or the values of iron oxide in the flux, which was still unknown, because he was under the misapprehension that the iron oxide was magnetic and that in some way it made the welding better. That is all I got out of the Robinoff patent."

Do you recall your answer?

A. I think that was my answer, yes, sir.

Q. I hand you a copy of the Robinoff Patent, bearing No. 1,782,316, issued November 18, 1930, and I call your attention to the first column, beginning at line 45 in the specifications.

As I read it, will you tell me whether or not you recall this in the Robinoff Patent:

"After the groove has been filled with flux, the welding head of the welding machine, having a reel of welding rod or electrode wire thereon, is started in operation to feed the electrode down into welding position, with respect to the flux-filled groove, and also to feed the electrode longitudinally of the groove.

274 "After the electrode is brought into proper position, an arc will be struck, so as to melt the flux in the groove; also to melt the metal of the electrode, so as to furnish a deposit of metal in the groove."

Do you recall that in the Robinoff Patent?

A. I do now, yes.

275 Q. Continuing:

"As the welding operation progresses the welding rod will be continually melted and deposit the molten metal through the molten flux in the groove, and the metal being of greater specific gravity than the molten flux will cause the flux to rise in the groove as the metal is deposited. The movement of the welding head is so timed that the proper amount of molten metal will be deposited to fill the groove the desired amount as the head passes along the groove."

One further paragraph:

"In carrying out this method the molten metal deposited from the electrode is at all times covered by a layer of the flux in the form of a slag and therefore the deposited

metal from the electrode will remain molten a sufficient time to permit any entraining gases to escape and the deposited metal will not become oxidized since the flux or slag protects the molten metal from the atmosphere."

Do you now recall those statements appearing in the Robinoff patent?

276 A. Yes.

Q. And that was the patent originally first cited by the Patent Office?

A. That is true.

Q. The Robinoff patent, from what I have read you, quite clearly is dependent on an arc, an electric arc, as a means of providing heat for the flux and the rod, is it not?

A. That is true.

Q. What difference, except for the flux, the composition of the flux, is there between all of the welding tests you made in your laboratory in 1932 and your description to the Patent Office of your so-called welding process? What difference is there from that of Robinoff?

A. Why, our electrode was always in contact with a fluid pool.

Q. It was always, in your tests, always in contact with the fluid pool in your tests?

A. In all our successful tests, yes.

Q. If open arc flashing appeared, I believe you said yesterday, that would mean it was no longer in contact, is that correct?

A. No, I don't construe explosions of flux that
277 might—you might be on the verge of not being in contact. That is, you might be submerged, but only a little bit, and extraneous explosions of gas might project particles in the air; but I would say substantially it would be functioning according to our process if the electrode was in contact with the molten pool.

Q. If it is in contact you do not have open arc flashing except rarely, is that right?

A. I would say that was true.

Q. That is the difference, you say, between your tests and the Robinoff process as described in that patent?

A. That is the difference between our process and the Robinoff process.

Q. But in your application specifications which you drew, the first application, you described it as submerged arc-welding, did you not?

A. We did.

Q. The question can be answered yes or no.

A. We did.

Q. But after you had assigned your patent and acquired new patent attorneys and the new application as you have testified was drawn up by them, a different description was given of your process which, I believe you agreed this morning, was described entirely different from the arc process?

278

A. That is true.

Q. Handing you what has been marked Plaintiff's Exhibit 126, which I believe it is agreed is the file wrapper of the second application—correct?

A. Yes.

Q. This was prepared, you will recall, was it not, by Mr. Sheffler of the Union Carbide & Carbon Company's patent counsel, office counsel?

A. That is true.

Q. And it was submitted to you in that form for signature?

A. That is correct.

Q. The title of the first application was, "A Method of Electric Arc Welding", was it not? I am referring to the first application, not that one. That is correct, is it not, the title of the first application?

A. Yes.

Q. The title there is what? The title of the second application is what?

A. Where does one find the title?

279

The Court: Not that I want to suggest that counsel deviate from his cross-examination, but are not these in evidence?

Mr. Stewart: Yes. They have been offered.

The Court: Would it not be apparent as to what it was?

Mr. Stewart: Yes. The title is "A Method of Electric Welding."

The Court: If they are in evidence, that would be ascertainable.

Mr. Stewart: I believe we can save time that way.

By Mr. Stewart:

Q. Calling your attention, Mr. Kennedy, to this application on page 2 appears the following statement:

"Among the various ways in which electrical energy has been converted into heat for the welding of metals, the

arc process which takes several forms is the most
280 generally practiced."

That statement you subscribed in that application, did you not?

Mr. Cahill: "Which itself takes several forms."

Mr. Stewart: "Which itself takes several forms, is the most generally practised."

By Mr. Stewart:

Q. You agreed with that when you signed the application?

A. Yes, I did.

Q. On the same page the following appears, does it not: "The requisite heat is developed as the term 'arc process' implies by maintaining either a direct current or an alternating current arc between the parts to be welded."

You agreed with that?

A. Yes.

Q. Turning to page 4 of the application, will you refer to the paragraph that begins "We have discovered." Do you find that?

A. Yes, I do.

Q. (Reading): "We have discovered a novel process
281 of welding which resembles the arc process in many ways, but it is essentially different from all arc processes and uses no arc."

That is the typewritten form of the application, is it not?

A. It is.

Q. Continuing:

"As in prior processes the necessary heat is generated in our process by causing a heavy electrical current to flow across a region of relatively high electrical resistance, and thence to a member onto which the metal is to be deposited, but in our process the resistance is provided not by a body of ionized gas but by a conductive melt."

You subscribed to that statement?

A. Yes.

Q. And by "a body of ionized gas", that was the type of arc with which you were familiar?

A. That is true.

Q. In arc-welding?

A. That is true.

283 Q. Mr. Kennedy, every paper submitted to the Patent Office on your behalf, and on behalf of Messrs.

Jones and Rotermund, were submitted to you before it was sent to the Patent Office; that is correct, is it not?

A. Yes, sir.

Q. And you at that time agreed to the correctness of every statement so made; is that correct?

A. We did.

Q. Do you recall that you were advised that the Patent Office again cited the Robinoff Patent, and rejected your claims because of it?

A. I don't recall that.

Q. You do not recall that?

A. No, sir, I don't. It is too long ago, too long since the events happened.

Q. After some time a third application was filed on your behalf, was it not?

284. A. Yes, sir.

Q. And that was the application that finally resulted in the patent in suit, was it not?—Handing you what has been marked Plaintiff's Exhibit No. 127, which is the File Wrapper of the third application.

A. Yes, sir.

Q. The same thing is true with regard to all of the papers filed in connection with this, as was in connection with the second application, so far as your seeing them and agreeing with their contents, is concerned?

A. We saw them, and we agreed with their contents, and collaborated in experimental work to derive their contents.

Q. And you have no recollection of any discussion, that the Robinoff Patent had been cited as a bar to your patent?

A. I cannot recall it, no, sir. I know that it was, however, because I have seen some of the papers, but I don't recall it.

Q. You do not remember it at all?

A. No, sir, I don't.

Q. I call your attention to only one document in that file wrapper, and that is the one which is dated No-
285 vember 23, 1935. I will have to locate it for you. It is indicated in pencil as page 31 of the entire File Wrapper.

I call your attention to the last paragraph on that page.

Q. The statement appears, does it not, as a representation on your behalf to the Patent Office:

"The basically novel concept is in fusion welding by deposition from an electrode, using an electric current as the source of heat, without the use of a gas conducted arc. Hitherto it has never occurred to anyone that such a thing would be even possible of attainment, as is witnessed by the immense amount of effort being put into the development of arc-welding."

286 You agreed with that statement?

A. Yes.

By Mr. Stewart:

Q. Turn two pages over from there, Mr. Kennedy, and this will be the last one. Find the paragraph which begins "It is noted".

"It is noted that the Examiner uses the term 'arc-welding' in connection with Applicants' process. It is pointed out that the present invention does not involve a gas-
287 conducted arc, thereby disinguishing radically from all prior fusion-deposition electric welding processes."

You agreed with that at that time, did you not, as related to your alleged invention?

A. That is true.

Q. And that radically distinguished, did it not, your process from the Robinoff process?

A. Yes.

Q. Now, Mr. Kennedy, in preparing various ingredients that you put together for fluxes in your laboratory, you found, did you not, that even if you had ingredients that in certain proportions worked satisfactorily in your flux, different proportions of the same ingredients
288 would not work satisfactorily, did you not?

A. Maybe not under identical circumstances. I would say—

Q. Well, let's keep the circumstances the same.

Mr. Cahill: Let him finish the answer.

The Witness: One proportion might be better than another proportion. We didn't find it so critical as that.

By Mr. Stewart:

Q. Do you recall your visit to the Union Carbide Laboratories in Long Island in early 1934?

A. Yes, I do.

Q. Before you had gone there, you were told, were you not, that they had tried to duplicate your flux?

A. My recollection of it was that they tried to duplicate it when I was there.

Q. You were there for that attempt to duplicate your flux?

A. And to help them with the development of the process.

289 Q. And when you first made your flux, tried to prefuse it and duplicate it, it didn't work, did it?

A. It didn't work as well as it had worked before, and it was obviously—the welds made by it were obviously inferior to the welds that we made with the flux that we brought from California.

Q. Yet it was prepared exactly in accordance with your specifications?

A. Because our specifications—we were misled in writing our specifications, because we used calcium carbonate which we derived from a pottery adjacent to us, and unknown to us, it contained 6 per cent aluminum oxide that we didn't know about. We assumed that it was the calcium carbonate like we had used; but it contained 6 per cent aluminum oxide, which we were unaware of and which we found out by analysis when I arrived in New York.

Q. Up to that time you didn't know that you had aluminum oxide in your flux?

A. We had made flux in which we had aluminum oxide, and presumably got no effects from the aluminum oxide, because it was already present in the calcium carbonate.

290 Q. Aluminum oxide is a product which you can find in a material by chemical analysis only after determining the presence of aluminum, is that not correct?

A. The presence of aluminum in a compound that contains oxygen would lead you to suspect that aluminum oxide is present.

Q. Could it not be aluminum silicate?

A. I make no pretense to know what specific compounds are formed after fusion. I only know the compounds that enter the flux to compose the flux. Under the circumstances of high temperature I would not even make a guess as to how those elements combine.

Q. You do not know.

A. I have no knowledge.

Q. You have found, however, that on analysis a chemist was able to determine that there was aluminum in your

flux which you had not realized was there, and he assumed it was in the form of aluminum oxide from this analysis?

A. He merely reported aluminum present, and it was obvious to us that the aluminum came from aluminum oxide that was present in the calcium carbonate that we used.

Q. Aluminum oxide you knew was in the Western Pipe clay flux, did you not?

291 A. I knew that was one of the components yes.

Q. That was one, and you found it to be an essential ingredient in yours, correct?

A. We found that it was a desirable ingredient, yes.

Q. Well, when you made your flux without it, it did not operate very well, did it?

A. Yes, it did. It operated, but it did not operate as well.

Q. Were the welds full of holes?

A. I do not believe they were.

Q. Do you recall discussing it with Mr. Cornwell?

A. Yes, I do. He made the observation, "These welds do not look as good as they did in California", and furthermore, when we formed the flux, after it chilled instead of a glassy appearance it had a crystalline appearance.

Q. Referring to Defendants' Exhibit marked 65, the letter from Mr. Cornwell to Mr. Hirst, did you tell Mr. Cornwell at that time that:

"The welds produced from the first flux made at Niagara Falls were full of holes and it was quite evident that the flux was entirely unsuited for the welding process. In a way we were glad to find this to be true, as it estab-
292 lished that not just any combination of materials could be used for a flux."

Did you not tell Mr. Cornwell that? Did you not tell him those facts after that demonstration?

A. I do not remember that I did. I do not remember the weld being full of holes. It may have been—I am not denying it—but I thought Mr. Cornwell was pretty alert to recognize the fact that the weld did not look quite the same.

Q. Whether it had holes or not?

A. I remember the weld and I do not remember it had holes, or how they found it out, because I do not remember either X-raying or breaking the weld.

Q. So you do not recall where he could have gotten his information about holes?

A. I do not. I do not deny it, however, but I knew the fluxing material was not identical with the flux that we brought to New York with us.

Q. Yesterday, Mr. Kennedy, you testified that you tried to use borax as one of the ingredients and you found that it was unsatisfactory.

A. I found that boron gave a multitude of little cracks in the weld.

293 Q. And was that boron in the form of boro-silicate when you used it?

A. It entered the flux as sodium tetraborate, or borax.

Q. Borax.

A. How it reacted under the conditions of high temperature, I do not think I know.

Q. You do—

A. That is, when there are many elements present and they are subjected to high temperature and fusion, it is exceedingly difficult to find out how those elements pair off, and I would not pretend to be sufficient of a chemist to know.

Q. You do claim to know, however, that by pre-fusing calcium oxide and silica, you will get calcium silicate?

A. Because, in a simple system containing two components, the answer is very simple and obvious.

When three components are involved, it is more complex; and I think with four components, it is hopeless.

Q. So that when you used calcium oxide,—and I now quote from your patent — magnesium oxide, aluminum oxide, calcium fluoride and silicon dioxide, it would be hopeless, in your opinion, to tell what you had?

294 A. No, I don't believe so.

Q. Did you not just say that?

A. Well, I said it, yes, sir, but it needs a little modification. The major components, the acid members and the basic members, will react.

The calcium fluoride, even in the furnace, acts as a sort of a fluid, a liquid; it becomes a liquid more readily than the others; and whether or not it is a mechanical mixture, it continues as calcium fluoride interspersed between the calcium magnesium silicate, I would not be able to say.

Q. Did you ever use barium silicate?

A. Yes, we did.

Q. Can you show me where in your experimental notes that appears?

A. They are not in the experimental notes, no, sir. The occasion for using barium silicate was this: Jones was interested in the ability of a metal to emit electrons, and barium is a good emitter, and he wondered, if we were to make a weld with barium silicate, if barium might not enter the metal, and possibly it would be a good electron emitter.

That was the occasion for making a barium silicate
295 weld. It was not because we expected to use barium commercially.

Q. What kind of a weld did it make?

A. Well, it was a very small proposition. He was not trying to make a weld; he made a little button of metal, that was deposited, with barium present in the flux.

Q. So that you do not know whether barium silicate flux, even with calcium fluoride mixed with it, or with a little aluminum mixed with it, would be a satisfactory welding flux or not, do you?

A. If one were trying to make an electron emitting weld, it might be a very satisfactory flux, yes, sir.

Q. I mean a satisfactory flux commercially for your process, regardless of the cost.

A. Oh, I would say that it would not be useful, nor did we think that it would be useful for the purposes of welding plates together.

Q. Barium is one of the three recognized alkaline earth metals, is it not?

A. It is.

Q. Now, Mr. Kennedy, just briefly: Calcium fluoride in fluxes, and I use the term broadly, that is fluxes
296 for electric furnaces, blast furnaces, wrought iron furnaces, cupolas, and electric welding, is as old as each industry itself, is it not?

A. It is well known metallurgically, yes, sir.

Q. Where does the word "fluorine" come from, other than the old Roman word "fluo"? Was it not used in ancient Roman times for the same purpose, to lower the melting point of steel?

A. It does not lower the melting point of steel, no, sir.

Q. It lowers the melting point of the combination of the flux and the steel, does it not?

A. No, sir, it lowers the melting point of the flux.

Q. Of the flux.

A. Yes, but not the steel.

Q. But it has been used to lower the melting point of fluxes for many purposes, for many years, has it not, prior to your use of it in welding?

A. I am sure that it has, yes, sir. We did not claim to have first discovered the property.

Q. It had been used, now, to your knowledge, in welding fluxes, electric welding?

A. No, not to my knowledge.

Q. You do not know of any?

A. I didn't know of any.

297 Q. All right. Then, Mr. Kennedy, in your entire range of experimentation at Western Pipe, in your notes, which I believe you stated recorded your experiments, you refer to arc-welding throughout, do you not?

A. We did, yes.

Q. In your application, the specifications for which you prepared personally, you describe your process as submerged arc-welding; is that corect?

A. We did.

Q. The Robinoff patent, now that you have seen it, again, calls for arc-welding under a layer of flux, does it not?

A. It does.

Q. After you had assigned your patent, and agreed to Union Carbide's lawyers prosecuting the patent on your behalf, the process described by them, to which you agreed, was distinguished from arc-welding, and was resistance welding, was it not?

A. Not resistance welding as resistance welding is normally interpreted.

Q. Not pressure resistance welding, but the heat was provided by the conductive melt, and not by an arc in a gaseous medium?

298 A. That was the best of our understanding at the time we signed the application, that we were trying to give the examiner the latest and best information that we had on the subject.

Q. Are you familiar with the Unionmelt licensing agreements?

A. No, sir, I am not, particularly. I knew that there was a license—

Q. You have a slight interest in them, have you not?

A. Yes, sir. It has been remunerative to me, but in spite of that, my interest is still in the experimentation,

and I am quite unaware of the condition of the license agreement.

300 Q. Mr. Kennedy, there are two principal means of generating heat by electricity, are there not, and one is the electric arc, and the other one is by resistance.

Mr. Brown: In welding.

By Mr. Stewart:

Q. That is, in welding.

A. Yes, that is true.

Q. There are those two?

A. Yes, sir.

Q. If there is no contact between the electrode, and either the plate, or your flux, you could not have resistance welding, but you would have arc-welding; that is correct, is it not?

A. Well now, just a moment.

Q. Is that correct?

A. I would like to qualify that first statement. All heat is developed by the passage of electricity through resistance, regardless of whether that resistance is supplied by an ionized gap, or by a wire, or by a flux.

Now, with that modification—

Q. Did you say "gap" or "gas"?

A. Gas, I meant to say. The passage of an elec-

301 tric current through a resistance, develops heat.

Q. And one method is what is known as the electric arc, and that is passing it through ionized gas?

A. Yes.

Q. Is that correct?

A. That is true.

Mr. Cahill: If your Honor please, I think that counsel has an unanswered question. Is counsel abandoning the question, or does he press it?

Mr. Stewart: Will you read the original question, please, Mr. Reporter.

(The question was read.)

The Witness: Under those circumstances, if the current passes through an ionized gap or gas, and subsequently passes into a liquid flux, the heat will be developed by the arc passing through the ionized gas, plus the current passing through the conductive melt, if that happens to be the particular set up which you are investigating.

By Mr. Stewart:

Q. If your resistance is high in any material, you
302 need a high voltage to put any sizable current through it, do you not?

A. Ohm laid down those basic principles a long time ago.

Q. To put more current through any substance that has resistance characteristics requires increased voltage?

A. That is true, or lowered resistance; and a rise of temperature of the resistor will lower—can lower its resistance so that the same voltage might have more current flow as it got hotter.

Q. That would be a continuing thing and would create a curve, would it not, that is, the graph of that curve would be increasingly higher?

A. It could, if you take a measure on it.

303 Q. Put it this way, Mr. Kennedy: In order to pass an increased amount of current through a body that is resistant to current, you have to increase the voltage?

A. That is correct.

Q. On the other hand, to pass an increased amount of current by means of an electric arc, you can use this same voltage?

A. You can also do that with any conductor that becomes more conductive as it gets hotter.

304 The Court: You better answer it directly. If you preface the answer with "Yes" or "No", I think you can then go on with your answer.

The Witness: The answer is yes, that is true of an arc, but it is also true of any conductor with what electricians or engineers call negative temperature coefficient; that is, the arc becomes more conductive as it gets fatter with more current, therefore becomes more conductive.

By Mr. Stewart:

Q. Mr. Kennedy, when your deposition was taken you said you looked at your process through a fluoroscope. Do you recall that?

A. Yes. I did.

Q. Can you tell me just what type of X-ray appara-
305 tus you used?

A. Yes, I can. We used a dental X-ray.

By Mr. Stewart:

Q. And you were attempting to determine, at the time of the Western Pipe suit, whether you had an arc or not, by that means, were you not?

A. We were.

Q. And that test, you testified, was indeterminative?

A. I still say that that is true.

Q. X-rays reflect, either on a negative or on a screen if you use a fluoroscope, the relative ray absorption of the materials you are looking through, is that correct?

A. That is the principle.

Q. On negatives a material which has very high X-ray absorptive qualities, like steel, will show up as a light area on a negative, will it not?

A. It shows up black on a fluoroscope.

Q. I am asking about a negative.

306 A. Yes.

Q. And materials of less X-ray absorptive characteristics will show up as darker on a negative?

A. Yes. The relative density of the material is what makes the X-ray intelligible.

Q. Did you make any determinations of the densities of your flux?

A. No, we did not. The fluoroscope was our only—the only device that was used to attempt to determine what was happening.

Q. And in your opinion it proved nothing?

A. It was not conclusive.

307 Q. Have you seen any attempts today to determine the presence or absence of an arc under a flux—

A. Yes.

Q. —by X-ray?

A. Yes, I have.

Q. Do they show a gaseous area, or do you know?

A. No. They are still indeterminate.

Q. You do not know?

A. No. I do not know.

Q. How does the metal get across from the electrode to the plate in your process?

A. In San Francisco I testified that I was curious to know.

Q. You do not know?

A. And I am just as curious now. The fact is, when the arc is open and perfectly visible, the mechanism of the

metal transference is not clear to me, and I do not think clear to anybody.

308 Mr. Stewart: That is all.

322 The following proceedings were had at the plant of the Linde Air Products Company, 4400 Kennedy Ave., East Chicago, Indiana.

Present: Same as before.

Mr. Wolfe: If the Court please, we have a series of demonstrations this morning that we propose to make in conformity with the schedule that we furnished the Defendants last Thursday. We have a number of extra copies of that schedule which will probably be a convenience for the Court and the others present in following these demonstrations.

323 Mr. Mason will distribute those copies,

The general purpose of these demonstrations this morning is primarily to give the Court an opportunity to simply see a few of these welding techniques or processes to which the witnesses have and will, in the course of the trial, refer, so that it will be easier to visualize what they are talking about and follow the testimony that will be developed as the case goes along.

The first item for demonstration here, No. 1, is hand welding with a bare electrode. The actual welding in that case, and in the other cases here will be done by the operator, Mr. Harold Roberts, who is one of the Linde Company's service men. Mr. Kennedy who is the current witness is, of course, here, and we can through him bring out any necessary testimony as to operating conditions and things of that kind.

Now, we have a number of safety shields here, although not enough for everybody, and of course during the first hand welding operation with a bare arc, we will have to take some precautions against eye-burn, by not looking

324 directly at it.

I would suggest to your Honor that during the operation you hold the shield somewhat to one side, or simply shade your eyes with your hand so you can get an idea of what the general illumination and effect of the process is.

The safety shield itself is so completely opaque that you will find in this light you cannot see anything with it; and even when the arc is going, you can see only a bright spot

right at the welding; so you can get a little better idea of the over-all effect by just looking past the high side of the shield, or something of that kind.

The program here points out the equipment that is being used for this first hand welding, this first demonstration. It is a 3/16ths inch bare rod, GE, type L, and the current in the first welding will be 220 amperes, direct current, straight polarity.

(The demonstration was then given.)

325 Mr. Wolfe: Now, as the second part of this same demonstration, the welder will increase the electric current to 600 amperes, again using the same current, straight polarity, the purpose being to show the comparative effect of a much higher current, 600 amperes, as compared with 200 amperes, that he was using previously.

(The demonstration was then given.)

Mr. Wolfe: The welding rod used has become red hot. It is not full length, it is broken there, but I think that it will be sufficient for our purposes this morning.

The second item of the demonstration listed here as No. 2, is again hand-welding, this time with a coated electrode, the same type of electrode, a three-sixteenths of an inch coated rod, GE type W-24, of which some samples were offered in evidence the other day.

In this instance the current will be 225 amperes, again direct current, straight polarity; and the operator will make a weld in the V groove in this second set of small sample plates.

326 (The demonstration was then given.)

Mr. Wolfe: Would your Honor care to step down and see the plates? The operator is chipping off the slag left by the coated rod.

We can have all of these various items marked a little later on. I think perhaps we can handle it more efficiently, or more expeditiously, to do it that way, rather than try to take them individually.

Now, the third main item of demonstration here is automatic welding with a half-inch plate, which will be done right in front of your Honor.

In this case they will use Unionmelt Grade 20, one of the standard grades of welding composition of this Unionmelt welding process in suit; and the other details of the setup are as mentioned.

These are half-inch steel plates; they have been prepared

with a 60 degree included angle, beveled where they are to be welded with a three-sixteenths of an inch nose.

The welding rod is a quarter-inch Oxweld No. 36 rod, and the current in this case will go up to 850 amperes, as compared to the 200 and 225 amperes which we saw
327 with the hand-welding.

The voltage will be 28 volts, with reversed polarity, and the travel speed of the welding rod along the plate will be set for 16 inches per minute.

The plates have, as you see, been tack-welded together at the ends, and clamped in place here on the table, and the operator has placed a wad of steel wool beneath the end of the welding rod, or electrode there, all ready to start the welding.

The next step will be to start the feed of the welding composition from the hopper, to come down on the rod, as you will see; and then he will start.

(The demonstration was then given.)

Mr. Byron: We would like to have noted the depth of the flux.

Mr. Wolfe: We will have one of the men measure that.

328 HARRY EDWARD KENNEDY, called as a witness on behalf of the plaintiff, having been previously duly sworn, resumed the stand and testified further as follows:

Mr. Wolfe: Mr. Kennedy, will you take this ruler and measure the depth of the flux so that you will be able to state for us what it is.

The Witness: Yes.

Mr. Byron: Just a moment, please. The flux, where the wire is approaching, is considerably higher than this.

Mr. Wolfe: All right. Will you also measure the height of the bottom of the tube through which the flux was fed, so that you can give us both of those dimensions.

The Witness: (Measuring) The bottom of the tube is an inch and a half, in this one.

Mr. Byron: No, more than that.

The Witness: Just a moment. It is more than that. That scale does not start at zero. It is an inch and three-quarters.

Mr. Byron: Take the high end of the tube, please, where the flux came out. That is on a bevel.

329 The Witness: The tube is on a bevel.

Mr. Byron: Yes, so let us have the true dimension there, please.

The Witness: The minimum distance of the tube from the plate is one and three-quarters inches, and the maximum distance is two inches.

Mr. Oberlin: Two inches on the trailing side.

The Witness: Yes.

Mr. Wolfe: And then as to the height of the remaining mound, after the weld has been completed.

The Witness: I would say, an inch and a half—just a moment. Yes, an inch and a half.

Mr. Wolfe: Now, Mr. Byron, if you care to do so, perhaps, you would like to take a sample of this flux before they clean it off of here.

330 Mr. Byron: Yes, we would; not only a sample of the flux that was used, but also a sample of the weld rod.

Mr. Wolfe: All right.

The Court: Do you care to have marked these samples that have been taken, Mr. Byron?

Mr. Byron: What is that?

The Court: Do you care to mark these samples that have been taken?

Mr. Byron: Yes. We will wish to mark them.

Mr. Wolfe: We have some labels here. We can do it right now.

Mr. Byron: I thought we would let you mark them when you mark everything.

Mr. Wolfe: Perhaps we had better have these marked now. I will ask the Reporter to mark these samples of flux here for identification as Plaintiff's Exhibits 133-A and 133-B.

(Whereupon said articles were marked Plaintiff's Exhibits 133-A and 133-B for identification.)

Mr. Wolfe: I will ask the Reporter to mark this sample of the weld rod as Plaintiff's Exhibit 134.

331 (Whereupon said article was marked Plaintiff's Exhibit No. 134 for identification.)

Mr. Byron: We would like also to have the stub end of the coated weld rod that was used in this second one marked as an exhibit.

Mr. Wolfe: I will ask the Reporter to mark the stub end of the coated rod as Plaintiff's Exhibit 135 for identification.

(Whereupon said article was marked Plaintiff's Exhibit No. 135 for identification.)

Mr. Byron: And the stud end of the bare electrode used in the first demonstration.

Mr. Wolfe: I will ask Reporter to mark that as Plaintiff's Exhibit 136 for identification.

(Whereupon said article was marked Plaintiff's Exhibit No. 136 for identification.)

Mr. Wolfe: Now I will ask the operator to clear off the flux from the plate that has been welded here in this last demonstration so we can see the completed void.

332 I think it would be a good idea if we put a couple of these pieces of slag in. I will ask that that be put in a bottle and marked for identification as Plaintiff's Exhibit 137.

(Whereupon said article was marked Plaintiff's Exhibit 137 for identification.)

Mr. Wolfe: Now, the next item is No. 4 on this schedule of demonstrations. It will be carried on on this right-hand table over here. In this instance we have still heavier plates, that is, one inch steel plates, which have been bevelled and tacked together, as compared to the half-inch plates that were used in the last demonstration.

The welding rod, as indicated in the program, in this case is a 5/16 inch Oxweld No. 36 rod. The plate is bevelled with 35 degree included angle, including a 1/8th inch nose. Alternating current will be used here, and in this instance 1550 amperes at 41 volts; and the travel of the head along the plate will be 11 inches per minute.

Now, on approximately the first half of the plate, 333 Unionmelt 20 welding composition or flux has been put in place; and on the second half a clay flux, that is, the clay flux of which we previously furnished the Defendants a 50-pound sample, and our analysis of the composition is given here in tabular form on the program.

As the welding head goes along its travel will not be interrupted, but we will simply continue the weld with first the Unionmelt flux and then this clay flux.

Mr. Byron: Just a minute. I think it would be a good idea to measure the height or depth of the flux before we start the operation.

Mr. Wolfe: All right. Mr. Kennedy, will you do that, please?

Mr. Byron: Incidentally, I notice that the flux on the

left-hand side here, the clay flux, is not as high as it is on the other side.

Mr. Wolfe: Have you a can of clay flux here? Build it up a little so we are sure they are the same.

Mr. Roberts: It is hard stuff to pile up. It sloughs all over the place.

334 The Witness: The maximum depth of the flux is 2½ inches on the Unionmelt flux.

Mr. Byron: Level it down to the same.

The Witness: The depth of the clay flux averages two and a half inches. Mr. Wolfe, in stating the current I think you misread it. I think you said 1050. It reads 1550.

Mr. Wolfe: Thank you.

Mr. Byron: I think it might be well at this point to let it be known to the Court that that process, includin the use of the clay flux, so-called clay flux, was never ca.ried out with 1550 amperes. That was not the regular commercial process. It was very much lower than that, not to exceed 650 to 700 amperes, instead of 1500 amperes.

Mr. Robinoff: Because the plates were only 9/62nds, and it was not an occasion of welding a one-inch plate.

Mr. Wolfe: Are you ready here? I think we had best stand back.

(The demonstration was then given.)

Mr. Byron: It is to be noted that the hopper is feeding more flux in connection with the Unionmelt, as the welding operation is going on. About 3/4 of an inch more is 335 being laid on top.

I would like to call attention to the fact that, as the welding operation was proceeding, there was no additional clay flux added during the welding operation.

Mr. Wolfe: Measure for us, Mr. Kennedy, the present height of the two mounds of flux where they clear the plate.

The Witness: Does somebody have the rule?

Mr. Roberts: Yes.

The Witness: This part has been raised slightly by what has been deposited on the Unionmelt flux. May I blow that off. It is a very negligible amount.

The height is an inch and a half.

Mr. Wolfe: That is for the Unionmelt?

The Witness: Yes.

Mr. Wolfe: And the other.

The Witness: The other is about two inches.

Mr. Wolfe: For the clay?

The Witness: Yes—an average of about two inches.

336 Mr. Wolfe: For the clay.

The Witness: Yes.

Mr. Stewart: Measure the crater.

The Witness: You mean, to level it off, to get the height of the crater?

Mr. Stewart: Measure it in the center of the weld.

The Witness: I would estimate this to be 3/4 of an inch below the top, and you would subtract that from the measurement I just gave, subtract 3/4 of an inch.

Mr. Stewart: Straight down to the fused clay.

The Witness: It is a very indeterminate amount. 3/4 of an inch is just my best estimate of it.

Mr. Stewart: Let me make just one statement here, Mr. Wolfe.

Watching the voltmeter while this machine was operating, in the first section, with the Unionmelt flux, the voltmeter varied from about 37 volts to 45 volts, with about the same variation on the clay flux, or as much as an 8-volt variation.

Mr. Wolfe: Now, I think that we had best take 337 sample of the clay, if you have another bottle here.

We will mark that as Plaintiff's Exhibit No. 138 for identification.

(Whereupon said article was marked Plaintiff's Exhibit No. 138 for identification.)

Mr. Wolfe: Now will you clean the plate, please, Mr. Roberts, so that we can see the finished weld.

Mr. Byron: Mr. Wolfe, we would like the active end of the electrode.

Mr. Wolfe: Oh, yes. Will you cut that off, please, and we will mark it as Plaintiff's Exhibit No. 139 for identification.

(Whereupon said article was marked Plaintiff's Exhibit No. 139 for identification.)

Mr. Stewart: May I look at that just a moment, please.

Mr. Byron: Do not let it fall on the floor, please.

Now, your Honor, the Defendants think that if these are supposed to be comparable tests, the Unionmelt end of this should be run over with the same amount of flux as 338 there was with the clay.

Mr. Oberlin: Without anything being added during the welding process.

Mr. Byron: Yes.

Mr. Oberlin: There is no way of determining how much additional flux was spilled from that tube, onto the pile, and therefore there is no basis for comparison between the two operations, unless the Plaintiff chooses to run the first one again, under proper conditions, that is, without any additional flux being fed onto the pile.

Mr. Wolfe: We are not going to undertake at this time to argue about proper conditions.

Now before those pieces of slag there are misplaced, we will ask that one of the pieces of slag off of the Unionmelt end, be marked as Plaintiff's Exhibit No. 140 for identification.

(Whereupon said article was marked Plaintiff's Exhibit No. 140 for identification.)

Mr. Wolfe: And we ask that a piece of slag off of the clay flux end, be marked as Plaintiff's Exhibit No. 141 for identification.

339 Mr. Byron: Plaintiff's Exhibit 140 is the electrode?

Mr. Wolfe: No.

Mr. Byron: Which is which?

Mr. Wolfe: Plaintiff's Exhibit No. 140 for identification is slag off of the Unionmelt end, and Plaintiff's Exhibit No. 141 for identification is slag off of the clay flux end.

(Whereupon said article was marked Plaintiff's Exhibit 141 for identification.)

Mr. Wolfe: We have another plate, that was welded under the same conditions, that has been cut open, so that you can see the inside; and I will ask the operators here if they will put that up alongside of this one, so that they can be compared.

Mr. Byron: We object to that because we were not here. That was an ex parte test. If you want anything of that nature, cut open the plate which was just welded.

Mr. Wolfe: That is what we are going to do. This is just as a matter of convenience, for the moment. May we have that put up here, please.

340 (The cut open plate referred to was placed on top of the machine.)

Mr. Byron: Your Honor, we do not know under what circumstances this plate which is now before us, and which is not the one on which the demonstraton was just made, was welded, or what the current was, that was used, or anything else about it. It was purely an ex part secret test,

and therefore we object to any consideration whatsoever being given to this plate which is now being exhibited to us for the first time, which counsel says was welded some days previously.

Mr. Wolfe: I will ask Mr. Kennedy a question or two along that line.

By Mr. Wolfe:

Q. Mr. Kennedy, were you present when this plate which has been cut open, was welded?

A. I was present when the plate exactly like this one that we just saw welded, was welded, and I assume his is the one that I saw welded.

Q. Where was that done?

A. Right here.

Q. On what equipment?

A. On this equipment here. It was welded exactly the
341 same at this plate that we just saw welded right here.

Q. Were there any differences in the condition, that you know of?

A. None that I know of.

Mr. Wolfe: Now we shall, your Honor, have these plates that have been welded here this morning, X-rayed and cut open, so that they can also be inspected. Our only purpose in doing this was a matter of convenience, something that would suffice for present purposes.

The Court: When the plate that has just been welded, is cut open, I suggest that a representative of the Defendants be present.

Mr. Wolfe: Yes, we shall be very glad to have him, your Honor.

Mr. Byron: It might be mentioned also that the plate which has just been shown to us, which apparently was welded some time ago, has not been marked in any way, and the witness, Mr. Kennedy, has not definitely identified the particular plate in any way. He says that he supposes, he assumes, and so forth, that it is the same plate.

342 Mr. Wolfe: I think we are ready now for the fifth and last of this series of demonstrations here. All right, gentlemen. If we can resume our places, I think the operators are ready for this No. 5 demonstration which is to be made over here on the lefthand table with the same welding rod which was used on the No. 3 demonstration.

In this instance we are using again the same clay flux

that was used for part of No. 4, but with, as you will see on the tabulation of conditions, here, a substantially smaller plate and current. In this instance the weld is to be made on a pair of steel plates five-sixteenths of an inch thick. They are beveled to provide a 70 degree included angle in the Vee with a feathered edge, but no nose. Current, 600 amperes, voltage, 30 volts, direct current being used with straight polarity, and the travel is to be 10 inches per minute. That is, the travel of the welding head along the plate. The operator has a ball of steel wool inserted under the welding rod preparatory to the start, and he
343 will put the rest of the clay on there to get it ready to go.

Mr. Stewart: Just a minute. The defendants would like to raise one point, and that is that on these two tests, the one with the Unionmelt flux which was run, I believe, at 850 amperes, and this No. 3, the plates obviously had been ground before the weld was made, removing all possible impurity; whereas on the one with the clay flux, the second one, the plates obviously have not been ground.

Mr. Wolfe: Mr. Kennedy, would you measure the height of the flux first, if you please?

The Witness: I would say the average height is two and a quarter inches.

Mr. Wolfe: Are you ready to go ahead, Mr. Roberts?

Mr. Roberts: Yes.

(The demonstration was then made.)

Mr. Stewart: I would like to make an observation.

Mr. Wolfe: All right.

Mr. Stewart: At this point on behalf of the defendants I would like to put in the record the fact that no one
344 in the room used a shield to watch that weld with the clay flux; and second, the backing used is a copper backing which has a very narrow groove—not even a groove; just a depression. The voltmeter during the operation varied from 28 to 34, and there was not a nose in the bevel of the plate.

Mr. Wolfe: Will you take a sample of the clay flux used there and mark it for identification as Plaintiff's Exhibit 142.

(Whereupon said article was marked Plaintiff's Exhibit 142 for identification.)

Mr. Wolfe: I will ask the Reporter also to mark a sample of the slag as Plaintiff's Exhibit 143 for identification.

(Whereupon said article was marked Plaintiff's Exhibit 143 for identification.)

Mr. Wolfe: I will ask that the end of the rod be marked Plaintiff's Exhibit 144 for identification.

(Whereupon said article was marked Plaintiff's Exhibit 144 for identification.)

345 Mr. Stewart: One other observation about the end of the weld rod. There is molten slag attached to it. It may be knocked off in the process of its being taken out of the machine. That is agreed, is it not, that it is there?

Mr. Wolfe: Do you want to have a look at it, Mr. Kennedy? I do not know what is on it.

Mr. Byron: Don't keep moving that thing.

The Witness: May I blow on it?

Mr. Byron: Yes.

The Witness: I am not so sure it is a wise thing to do. May I touch this?

Mr. Byron: Do not knock it off.

The Witness: I do not think there is any on to knock off. I do not think there is molten slag. I do not think there is molten flux on the end of the rod.

Mr. Stewart: Mr. Wolfe, may the record show that there is no indication on the plate analysis as to whether it is low-carbon, high-carbon or how it has been made, with respect to any of these tests.

Mr. Wolfe: I think we had best mark each of the various plates for identification that have been welded,

346 and then—

Mr. Byron: Just a minute.

Mr. Wolfe: Yes.

Mr. Byron: If you do not mind. We would like to have the end of this marked now. We would like to have the end of it, and then a longer piece also. We would like to have the two pieces marked.

Mr. Wolfe: We have assigned that a number. I thought it had been cut off.

Mr. Stewart: Mr. Kennedy, you may now have a better look at the end of the weld rod. I believe you said you could not see any flux, molten flux, on the end of it.

The Witness: I couldn't, from the angle I looked at it. I think there is a small amount of it on here.

Mr. Wolfe: Now, with respect to these various plates, I will ask that the one that was done with the hand welding and the bare rod be marked as Plaintiff's Exhibit 145 for identification.

(Whereupon said article was marked Plaintiff's Exhibit 145 for identification.)

347 Mr. Wolfe: I will ask that the plate which was welded with the hand welding and the coated rod be marked for identification as Plaintiff's Exhibit 146.

(Whereupon said article was marked Plaintiff's Exhibit 146 for identification.)

Mr. Wolfe: I will ask that the plate that was welded in demonstration No. 3 be marked Plaintiff's Exhibit 147 for identification.

(Whereupon said article was marked Plaintiff's Exhibit 147 for identification.)

Mr. Wolfe: I will ask that the plate welded in demonstration No. 4 be marked for identification as Plaintiff's Exhibit 148.

(Whereupon said article was marked Plaintiff's Exhibit 148 for identification.)

Mr. Wolfe: I ask that the plate welded in demonstraton No. 5 be marked Plaintiff's Exhibit 149 for identification.

(Whereupon said article was marked Plaintiff's Exhibit 149 for identification.)

348 Mr. Wolfe: With respect to each of the three plates, 147, 148 and 149, we would like to have those plates X-rayed, and 148 also to be cut open; and if the defendants will nominate somebody to participate or go along in that we will be happy to have them.

Mr. Byron: We will do so.

Mr. Wolfe: If the Court please, I think that concludes our demonstration for this morning.

The Court: Mr. Byron, and Mr. Oberlin: Are there any further questions or statements? Are there any further questions or statements from any counsel?

Mr. Wolfe: We shall want to make some further inquiry of Mr. Kennedy. We can do that when we get back to the court room rather than having to do it here.

Mr. Stewart: If the Court please, may I make one statement. It is my assumption that the welding operations performed with the Linde heads and Unionmelt flux represent the Unionmelt process.

Mr. Wolfe: Yes. That is right.

349 Mr. Stewart: Therefore I want to enter an objection to any such demonstration if it is to be claimed that that demonstrates the invention or the process of the patent in suit for the reason, first, that the flux layer was

considerably more than one-half inch in depth as originally described, and the flux layer was also not even shallow enough to comply with the Unionmelt Welding Operator's Manual from which I quote, published in 1945, which I believe you are familiar with, wherein on page 21 it is stated:

"The statement of Unionmelt used." under the heading of "Procedure Reminders"—"the layer of Unionmelt used should be just sufficiently deep to prevent open arc flashing."

I submit it was considerably deeper than that.

The Court: Is there anything further?

Mr. Byron: I think not.

The Court: Is there anything further from plaintiff's counsel?

Mr. Wolfe: No, not at this time.

The Court: Have all the exhibits been marked which will eventually be offered into evidence?

350 Mr. Byron: I beg your pardon?

The Court: Does either side have any other exhibits which they would like to have marked?

Mr. Byron: May we have a sample of that steel wool.

Mr. Wolfe: We can mark that as 150.

(Whereupon the article referred to was marked Plaintiff's Exhibit 150 for identification.)

The Court: Are there any others?

Mr. Byron: I think no.

The Court: If there is nothing further court will stand adjourned and resume at two o'clock in the court room.

351 HARRY EDWARD KENNEDY, called as a witness on behalf of the Plaintiff, having been previously duly sworn, resumed the stand and testified further as follows:

352 *Direct Examination (continued) by Mr. Cahill.*

Q. Mr. Kennedy, I want to direct your specific attention to the demonstration that we saw this morning. Referring specifically to demonstration No. 3, automatic welding on half-inch plate with Unionmelt 20: I want to ask you, how does that demonstration compare with the invention covered in your patent here in suit.

A. That demonstration was practiced entirely in accordance with the teachings of our patent.

It was made with the same flux that we used in making test, I believe 422, which was made with 68 flux, which was described in the patent.

Q. I want to put to you the same question as last I put, in regard to that part of demonstration No. 4 which you saw this morning, which was taken with Unionmelt 20.

A. The composition of Unionmelt 20 is the same composition as our flux 68.

Q. I want ask you generally with respect to the process practiced in that part of demonstration No. 4 which was made with Unionmelt 20: How does that compare with the process described in your patent?

A. The process as described in our patent is that 353 which we saw this morning.

Q. I am referring specifically at this time, Mr. Kennedy, to that part of the demonstartion No. 4, the first half, which was performed with Unionmelt 20, and I will ask you, how does that part of demonstration No. 4 compare with the process disclosed in your patent?

A. (No answer)

Q. Do you understand the question, Mr. Kennedy?

A. I thought I had answered it.

Q. Well, I am not sure that you did, specifically, so I am repeating it, in order that the record may be clear.

A. The welding was performed in accordance with our patent, because it used Unionmelt No. 20, which is identical in composition with that which we described, and was the same flux that we used in making Test 422.

354 Q. And was the first half of demonstration No. 4 in all other respects the same as the process disclosed in your patent?

A. It was identical. The flux was heaped up to a suitable height. I could see no deviation.

Mr. Cahill: If your Honor please, I think the mimeographed sheets describing what the tests consisted of may be marked for identification. I don't believe they have been. May I have that given a number?

The Court: Yes.

Mr. Cahill: Plaintiff's Exhibit 151.

(Whereupon the documents referred to were marked Plaintiff's Exhibit 151 for identification.)

By Mr. Cahill:

Q. Referring to the demonstration No. 5 with clay flux, and directing your attention specifically to that test at the moment, I ask you how demonstration No. 5 with clay flux compared with what you saw at Western Pipe in 1932?

A. The operation of the clay flux was in all respects identical to what we had seen at Western Pipe. The mechanism for feeding the rod was different, and the I think—and my memory may fail me here—I think there was more gas evolved and more clay projected, in the test at Western Pipe & Steel than there was this morning.

Q. Now, turning to the second half of demonstration No. 4 that you saw this morning—that is the one where the first half was done with Unionmelt 30 and the second half was done with clay flux—I ask you, with regard to the clay flux part of demonstration No. 4, how did that compare with what you saw at Western Pipe in 1932?

A. That is the one-inch plate? I never saw alternating current used on the clay flux, nor did I ever see a current of 1500 amperes, nor did I ever see an attempt made to weld a one-inch plate.

Mr. Cahill: That is all with that. We will go to something else.

By Mr. Cahill:

Q. Now, have you heretofore seen moving pictures shown of demonstrations performed under identical specifications and conditions with those we witnessed this
356 morning which are set forth on this mimeographed sheet marked Plaintiff's Exhibit 151 for identification?

A. I have.

Q. Now, I show you this reel and ask you if you can identify it from the tab appearing thereon as being such a reel of moving pictures?

A. I recognize it, yes.

361 Q. Mr. Kennedy, have you seen the moving picture of the demonstration heretofore made, of the four tests you saw this morning—or rather, three of the four tests that you saw this morning, described on Plain-
362 tiff's Exhibit No. 151 for identification.

A. Yes, I have seen it.

Mr. Cahill: I might state, your Honor, that the demonstrations that are on there are the two hand demon-

strations, that is, Nos. 1 and 2, 1 being with the bare rod and 2 being with the coated rod, and the No. 4 demonstration, the first half of the plate being the Unionmelt and the second half of the plate the clay flux.

By Mr. Cahill:

Q. Now, I ask you whether the pictures shown thereon fairly and accurately portray the practice of hand-welding with a bare rod, the practice of hand-welding with a coated electrode and the practice of your patent in so far as the first half of the third test, that is, the one with Unionmelt 20 is concerned? Do they or do they not accurately and fairly portray that?

363 The Witness: They all accurately depict the practices you have enunciated.

By Mr. Cahill:

Q. And so far as the use of the clay flux is concerned on the second half of the third test portrayed thereon, is your answer in respect to that the same as your answer was with respect to the second half of No. 4 seen this morning?

Q. (Continued) That is, the half of demonstration No. 4 this morning that dealt with clay flux?

The Witness: The demonstration No. 4, with the clay flux, in which an attempt was made to weld a one-inch plate with alternating current is a test which I have never witnessed before, because that was not done at Western Pipe and Steel.

Mr. Cahill: I will offer the reel. I have not had this identified, your Honor. Shall I have a number given to it? It will be 152.

364 (Whereupon the reel was marked Plaintiff's Exhibit No. 152 for identification.)

366 Q. Mr. Witness, I hand you five still photographs. I am going to ask you in respect of each of them, or of all of them, first whether these are still photographs of frames of movies which appear in the reel, Plaintiff's Exhibit 152 for identification.

A. They are.

Mr. Cahill: All right. These, I will state to the Court, were taken simultaneously at the time of the movies being taken by a separte still camera. We are just marking them for identifications at this time.

Mr. Stewart: Are you going to introduce these?

367 Mr. Cahill: No, because under the Court's ruling I thought we had reserved both the movies and the stills until you had a chance to look at them.

Mr. Van Duzer: When and where were they taken?

Mr. Cahill: At the same time the movies were made.

Mr. Van Duzer: We would like to know when and where the movies were made.

Mr. Cahill: I will ask my associates. They were taken on December 12, 1946, in the same demonstration room that we were at this morning.

I will ask that these five stills be given numbers for identification, and I will reserve offering them in accordance with your Honor's ruling on the movie.

Mr. Van Duzer: How are they identified?

Mr. Cahill: He is going to give them numbers now, and I will have the witness say which one gets which number.

(Whereupon said photographs were marked Plaintiff's Exhibits 153 to 157, both inclusive, for identification.)

368 Mr. Cahill: To avoid the witness giving any testimony, I will make the statements myself.

Exhibit 153 for identification is an automatic electric welding demonstration, demonstration No. 3, so-called, of this morning.

Mr. Wolfe: That should have been No. 4, I believe, Mr. Cahill.

Mr. Cahill: Or rather, I beg your pardon; No. 4, that should be. I should have said, 4.

Plaintiff's Exhibit No. 154 for identification is from test No. 4.

Plaintiff's Exhibit No. 155 for identification is from test No. 4.

Plaintiff's Exhibit No. 156 for identification is hand-welding with the coated rod, demonstration No. 2.

369 Plaintiff's Exhibit No. 157 is demonstration No. 1, hand-welding with the bare rod.

Now, may I have the rod which was shown to the witness at the demonstration this morning, the one with the protuberance at the end?

371 By Mr. Cahill:

Q. I want to direct your attention, now, Mr. Kennedy, to Plaintiff's Exhibit 144 for identification, which you were shown this morning at the demonstration room.

Calling your attention to this small piece of rod with a protuberance at the end, I will ask you if you have looked

at that, and if you have, tell us what in your opinion that protuberance is.

A. Well, I do not know that I could positively identify this protuberance. It might be metallic, or it might be flux. If it is flux, it represents a static condition—

372 A. The protuberance, which, as I say, I am not perfectly certain about, as to whether it may or may not be metallic; it may or may not be metallic, but if it is flux, it is entirely understandable, because when you are welding, you have a dynamic condition, and the force of the arc depresses the molten flux away from the weld.

The moment the current is shut off, that force no longer exists, and the flux might have contacted the rod, and beyond there, may have adhered to the rod. I see no significance in whether there is flux on here or not.

By Mr. Cahill:

373 Q. Now, turning again to the demonstration of this morning, you recall counsel for the defendants making a statement to the effect that the plate used in the No. 4 demonstration was ground, while the plate used in the No. 5 demonstration was not ground?

Do you recall that statement?

A. Yes.

Q. Now, will you please tell the Court what the effect of grinding is?

A. To remove iron oxide.

Q. Attention was called by counsel, you will recall, to the backing-up bar on demonstration No. 5.

What is a backing-up bar?

A. A backing-up bar is frequently called a chill bar. It is made of copper, because of its high heat conductivity.

The object of it is to chill and prevent from running out, metal that might otherwise leak out of the weld.

Q. Now, I want to ask you whether or not that bar that was in demonstration No. 5 this morning, was similar to the backing-up bar which you saw used at Western Pipe?

A. The important surface on it was identical, and by "the important surface" I mean that surface which was 374 in contact with the plates that were being welded.

At Western Pipe, the bar was not as wide as the bar that I saw, but it had an identical groove. As near as my memory serves me, the width of the groove was about half an inch, and it was about one-thirty second of an inch deep. It was planed in there.

The only difference between the bar at Western Pipe and the other bar was that it was wider, but functionally it was exactly the same.

378 *Cross-Examination by Mr. Stewart.*

Q. Mr. Kennedy, the last thing you testified about in connection with the backing plate was that that was the same that was used at Western Pipe.

The Court: Now, let me make an inquiry:

Just what do you mean by "backing plate"?

Mr. Stewart: The copper strip, your Honor, that was underneath the plate that was welded.

The Court: You may proceed.

By Mr. Stewart:

Q. You say that was the same that was used at Western Pipe?

A. I said it was functionally the same. I said the upper surface of the bar had the same groove that was at Western Pipe, although the bar at Western Pipe was narrower than the one that was used at this demonstration.

As a matter of fact, the bar at Western Pipe had to have a certain amount of flexibility to it because in order that it fit the varying curvature of the pipe, the copper had to be sufficiently flexible so it could be forced against the lower surface of the pipe and done so hydraulically, so it was not as rigid a bar as the one we saw this morning.

379 Q. Did they use any other type bars than was typified by that this morning at Western Pipe, backing up bars?

A. As far as I know, I think they made some experiments on different depths of grooves in the bar; but as far as I know, it was the same—they finally settled on a half inch groove with about a 32nds depression, a half inch groove and a 32nds inch depth.

Q. So that we are clear about that, do you mean that that copper bar in the demonstration—that was about four inches wide, was it not?

A. That is true.

Q. And it extended underneath the seam that was being welded?

A. That is true.

Q. And was right close up against it?

A. Yes.

Q. Immediately under the seam?

A. Yes.

Q. You say there was a slight depression about a half inch wide and a thirty-seconds of an inch deep?

A. That is correct.

Q. Now, at Western Pipe you say they did, to your knowledge, experiment with—whether they used it commercially or not you don't know—other types?

A. The bar I saw was commercially used.

380 Q. But whether they used commercially other types do you know?

A. I wouldn't be able to say I knew all the types they used.

D. Did they not experiment out there with a backing up bar that had a depression in the form of a V, a very wide V?

A. They may have, but I was not aware of it and never saw one.

Q. The backing up bar is an important preceding step, in getting a good weld, is it not?

A. It is essential. If the metal runs out on you you don't have a weld.

Q. And if you don't have proper backing up you will have porosity in the bottom of the weld, will you not?

A. I don't associate porosity and the function of the backing up bar. The backing up bar has for its function the prevention of run outs, and I don't associate proper backing up and porosity.

381 Mr. Stewart: I submit, your Honor, that can be answered "Yes" or "No".

The Witness: I don't think it can be answered "Yes" or "No". I don't associate—

The Court: Well, you answer it in the fashion you think you can properly answer.

The Witness: Porosity is not controlled by the backing up bar.

By Mr. Stewart:

Q. In other words, your answer is "No"?

Mr. Cahill: If your Honor please, I understand there is no rule of law that requires a witness to answer "Yes" or "No" if he says he cannot do it.

The Court: You may answer this question the best you can. If you cannot confine it to a straight answer of "Yes" or "No", you may state why you cannot.

Read the question.

(Question read.)

The Witness: Your Honor, I have answered it to
382 the best of my ability. I still say that the function of the backing up bar is to keep the molten metal from running away; and I don't associate porosity with that function.

The Court: You may proceed with the next question.

By Mr. Stewart:

Q. You are acquainted with water-cooled backing up bars, are you not?

A. I have heard of them; I have never seen them. I understand in the Western Pipe plant in Los Angeles that they use a water cooled backing up bar.

Q. With this same process?

A. I believe so.

Mr. Cahill: Referring to the clay process?

Mr. Stewart: The clay process, yes.

By Mr. Stewart:

Q. Now, Mr. Kennedy, in the demonstrations this morning, the welder, the operator there, did one weld with a bare rod, and there was quite a visible display of great light, was there not?

A. There was.

Q. There was also a great deal of smoke, was there not?

A. There was iron oxide in the air, if you call that
383 smoke.

Q. My question was purely what you could see. There was a great deal of smoke, fumes, coming up from the weld, was there not?

A. Well, I don't like to confuse iron oxide distributed in the air, and call it smoke, but there were fumes.

Q. And the atmosphere was a little beclouded, was it not?

A. I would agree.

Q. And when the welder used the coated rod there was a great deal of, if I may choose the words, smoke,—

A. I would agree.

Q. There was a great deal of gas emanating from
384 the welding zone?

A. But it wasn't the gas we saw, because all those gases are colorless. There were solid particles in the air.

Q. What did we see? What did we see that seemed to becloud the atmosphere?

A. Finely divided particles that extended into the air.

Q. That is not a gas to you?

A. No.

Q. The clay flux, when that operation was going on, a great quantity of finely divided particles were seen in the air, were they not?

A. I would agree.

Q. Would you say that there were no gases being exuded from the welding zone when the operator was using a coated hand electrode?

A. I am sure gases were being exuded from the welding zone, but they were not visible.

Q. All right; there were invisible gases and visible particles in the air?

A. With that I will agree.

Q. All right; and the weld made by that coated electrode, so far as you know, was not porous, was it?

A. I think it was an excellent weld.

385 An excellent weld, yet a great amount of gases and particles were being exuded from the welding zone, is that right?

A. That is true. They had an excellent opportunity to escape, and the amount of metal was very small.

386 Q. Now, the flux or slag, melted flux, after that operator finished his weld with the coated weld rod covered the metal, the weld metal, did it not?

A. It did.

Q. And you recall he had to chip it off?

A. I remember.

Q. And it appeared to be smooth on top, that slag, did it not?

A. I thought it was, yes.

Q. Yet it was full of holes, was it not?

A. I did not observe it particularly, but I could agree that it might be.

Q. You would agree that it was, will you not?

A. Well, I assume you have a piece in your pocket that is full of holes.

Q. That is right.

A. And I will not question it.

Mr. Stewart: Picked up there at the time.

By Mr. Stewart:

Q. So that the mere presence of holes in the slag does not prove that the weld is porous, does it?

A. I would agree.

Q. And the mere appearance of gases and particles in the air emanating from the welding zone do not mean that the weld will be porous?

387 A. I would agree with that.

Q. Now, that great light that we all looked at through shields in the hand-welding, what was that?

A. Well, that is a very difficult thing to give a definition of. I suppose it might be said that it was the result of any body at high temperature emanating light, and I would say that the gases and the electrode at extremely high temperature are a source of light, and that is what we saw.

Q. Wasn't that what is commonly known as an open arc?

A. You mean, when we had a bare rod?

Q. Yes, in the hand-welding.

A. That is right.

Q. And when the operator used the coated rod, that is what is commonly known as shielded arc-welding with a coated electrode?

A. That is true.

Q. That shielding consists of the gases that are produced by the heat of the arc?

A. That is correct.

Q. Is that correct?

A. That is correct.

Q. Gases that are emanated because of materials in the coating, and in the flux; is that correct?

A. Yes, sir.

388 Q. And that shields the arc, and the welding zone from the contaminating influence of the atmosphere?

A. Yes, sir.

Q. Is that correct?

A. Yes, sir.

Q. That is the principle of shielded arc-welding, is it not?

A. Yes, sir.

Q. And the layer of slag which appears afterward comes also from the coating on the electrode, and is designed to protect the molten metal, and keep it from cooling too fast; that is correct, is it not?

A. Yes, sir.

Q. Now, as you look through the shield, the helmet, the opaque glass, at the hand-welding operation, you do not see anywhere nearly as much light, do you?

A. No, sir. The purpose of that shield is to reduce the intensity of the light to a value that is not damaging to the eyes.

Q. If you look closely, you can see, right at the very tip of the electrode, what appears to be a little ball moving around, can you not?

A. I would say, yes.

Q. Varying in length, but probably not over one-eighth to three-sixteenths of an inch; is that not right?

A. Something like that.

389 Q. And that is what is known in the industry, and to you as an engineer, as the arc, is it not?

A. That is one type of arc, yes, sir.

Q. Electric arc?

A. I know of no other arc, except those in geometry.

Q. That is the welding arc, is it not?

A. Yes.

Q. Now, if you tried to look through the paper part of the helmet, you could not see it at all, could you?

A. Obviously not.

Q. In the clay flux demonstration, an electric arc was present, was it not?

A. I am sure that there was, yes, sir.

Q. You could not see it in the same manner that you could see the hand-welding arc could you?

A. No, sir. It was partially obscured by the clay flux.

Q. There was not a sufficient amount of flashing or damaging light, or injurious light, to hurt the eyes of us spectators, was there?

A. There would have been if you had directed your line of sight along the slot, yes, sir, that was being plowed by the electrode.

I would not want to look at that for half an hour.

390 Q. Now, how long does it take to get flashed, what a welder calls, get flashed, from a hand arc?

A. I think it is a matter of -

Q. It does not take half an hour, does it?

A. No.

Q. You can be in a matter of seconds, can you not?

A. It is a relatively rapid process; I will admit that.

Q. And yet there was an arc, you say, down under that flux?

A. Yes.

Q. The clay flux; is that right?

A. Right.

Q. It was not as visible as the hand-welding arc, was it?

A. No, sir. You did not have—that is, you had a rather limited angle through which you could see it.

Q. Well, the point is, it was visually shielded by the flux, was it not?

A. Partially.

Q. Now that flux, that clay flux has a very light specific gravity, has it not, in comparison to the Unionmelt flux?

A. I do not know the relative values.

Q. Just as a matter of comparison—well, it is
391 lighter, is it not?

A. I am not going to try to answer that question, because I do not know.

Q. Do you recall, as you faced the welding machine, the righthand demonstration, where the test was run with Unionmelt, a heavy, very heavy layer of Unionmelt, and a heavy layer of clay flux, when we asked for the measurement of the Unionmelt afterwards, it was covered with the powdered clay flux, which had blown over on there, and
392 you leaned over—and blew that clay flux off the Unionmelt, did you not?

A. I did.

394 In being able to blow that powdered clay flux off the other without disturbing the Unionmelt underneath, that was indicative to you, was it not, that the clay flux is considerably lighter?

A. No, not at all. That does not have anything to do with its specific gravity. It just indicates it was more finely divided.

Q. Can you tell by holding up these bottles if one is heavier than the other, and without looking at the labels tell me which is heavier than the other? The bottles are pretty heavy themselves.

A. This is the heavier (Indicating).

Q. Which is the heavier?

A. This one (Indicating).

Q. That you can tell from looking is the Unionmelt as opposed to the other?

A. I have not denied. I just did not know what
395 their relative specific gravities were.

Q. I did not ask you for any specific answer. All I am getting at, Mr. Kennedy, is that the clay flux is of less

specific gravity than the Unionmelt; you will agree to that, will you not?

A. I will after feeling their weights in the bottle.

Q. You did not know that before?

A. No, I did not.

Q. Never knew that before?

A. I did not.

Q. Also, Mr. Kennedy, you noticed, did you not, after the electrode in the clay flux operation had proceeded through the flux, there was a sort of a winding canyon down in toward the bottom of that flux left by the electrode? You noticed that, did you not?

A. Yes. That was the slot through which I saw the arc.

Q. So that if you had been able to pour flux, more flux down into that canyon as the electrode proceeded, you would not have seen the arc, would you?

A. I am quite sure you would. The forces involved
396 would have been sufficient to have made it break out some other place.

Q. You are sure of that?

A. I am perfectly sure of it. You cannot contain the arc by piling clay on it.

Q. You cannot? You are positive of that?

A. I have not been able to do so with any normal amount of clay piled on it.

Q. Does not the specific gravity of the clay and the particle size determine that?

A. Those are factors, but the important factor is the energy that is released underneath it that blows it in the air. That is the controlling factor.

Q. You mean, because there is an arc there?

A. I mean because there is a chemical reaction there that is projecting the clay into the air.

Q. You have never taken that flux, that clay flux that was used today, have you, and used it in larger particle size to try to submerge that arc?

A. Yes, we have.

Q. And, you say, with no success?

A. We did not find that we had a successful weld.

Q. My question was, submerge the arc from visual observation.

397 A. I will withdraw my answer. I was mistaken. We have not made the particle size larger in that particular material.

Q. So you do not know whether, if the particles were

larger, you could obscure the arc from the view of a spectator by using it?

398 The Witness: I do not know.

By Mr. Stewart:

Q. Now, in each of the automatic operations, regardless of which flux was being used, a little ball of steel wool was used, placed under the electrode in contact with the plate before the current was turned on, is that correct?

A. That is correct.

Q. And when the current was turned on an arc formed between the end of the electrode and the plate, did it not?

A. I am sure that it did.

Q. In each of those automatic demonstrations?

A. I am sure that it did.

Q. Regardless of flux?

A. I am sure that it did.

Q. Mr. Kennedy, when the Unionmelt flux was being used, an arc continued to exist between the electrode and the plate, did it not?

399 A. I testified in San Francisco that I did not know the mechanism of its operation, but of this I am sure, that it was not an arc of the usual type.

Q. Did you see any flashes emanating from the welding zone that would lead you to think there was an arc present while you were watching either of those Unionmelt demonstrations?

A. There was a display at the start, and after the start I saw no evidence to indicate what was happening in the welding zone.

Q. There was a fairly active bit of agitation going on down underneath that flux, was there not, movement?

A. I can conceive that there would be a great deal of turbulence in the welding zone.

Q. Turbulence; that accounted for the flux appearing to bounce up, being agitated on the surface?

400 A. It had the appearance to me of floating. The flux seemed to be floating on a liquid.

Q. Mr. Kennedy, as between those two fluxes, the clay and the Unionmelt, among other differences there were these, were there not: the clay is lighter in weight, per volume?

A. Per volume, yes; but individual particles of identically the same size, I am not ready to agree, because I don't know.

Q. The jar of one is heavier than the jar of the other, and that happens to be the Unionmelt jar?

A. I will agree, equal volumes, because there is more air in the clay than in the Unionmelt.

Q. Secondly, the clay was more finely divided than the Unionmelt?

A. That is true.

Q. Considerably finer. Do you know what mesh the clay was?

A. No, I do not.

Q. And, thirdly, in the clay, in the welding opera-
401 tion, great quantities of gas were given off, whereas that did not occur in the Unionmelt?

A. The gases were the result of chemical reaction that was taking place in the welding zone.

Q. And in your flux, one principal objective of the prefusion is to have all those reactions take place before its use, is that correct?

A. That is one of the objects.

Q. Now calling your attention to that demonstration which used the clay flux, at, I believe, 600 amperes, not the one where the clay and the Unionmelt were on the same plate:

In your direct examination you said that the plate where the clay flux was used, was not ground, whereas the one where the Unionmelt was used, was ground.

A. That was true.

Q. And you said that the purpose of grinding was to remove iron oxide, did you not?

A. Yes.

Q. You also remove any moisture by grinding, do you not?

A. I am quite sure that there was no moisture on the plate to be removed.

Q. To what temperature had that plate been heated
402 before it was used?

A. It had not been heated. I think that it was at room temperature when we began the weld: but in ordinary terminology, I would say that there wa. no moisture on the plate, any more than there is any moisture on this table here.

Q. The grinding would also remove any other impurities, or oxides on the plate, would it not, besides the iron oxide?

A. Whatever was contained in the layer that was removed, would obviously be removed, yes, sir, certainly.

Q. And, for the purposes of your flux there, the object was to remove what you consider to be a deleterious substance, namely, iron oxide; is that right?

A. Yes.

Q. The other plate, where the demonstration was made with both fluxes in succession on the same plate, was covered completely, that is, the welding zone was covered when we entered the demonstration room, was it not?

A. It was.

Q. So it was not possible from casual observation to see whether the plate had been ground or not?

A. It was perfectly evident—

403 Q. My question was, it was not possible to see?

A. It was not possible to see then, but after the weld was made, it was possible to see, and both sections had been ground. The marks of a grinding wheel are inescapable.

Q. It is true, Mr. Kennedy, is it not that the end of the weld is very often better than the beginning, as you proceed down the seam?

A. I have not made that observation.

Q. You never noticed that?

A. I have not made that observation. If you refer to the very beginning, I could agree that when we have an arc of a usual type, as we do when we start, one is apt to get a hole, but I have not been able to detect a gradual improvement in the properties as you go along the weld.

Q. You get a hole, do you not, because you do not immediately get complete shielding?

A. No; because the electrode is not immersed in a pool, because the pool is not formed.

Q. Whether you get your shielding by a pool or any other means, you get your hole because you do not have complete shielding, is that correct?

A. No. It is shielded most certainly because the flux, the granular flux, is all piled around it. Certainly
404 that is adequate shielding, if shielding was all that was necessary.

Q. You mean, flux is piled around and that is what you consider shielding?

A. I would say it was certainly shielding, but that is not sufficient in our case.

Q. It takes some inert material?

A. It takes more than that. It takes an inert liquid material that is conductive.

Q. You can, however, get complete shielding with inert gas or inert vapors, can you not?

A. You can dispossess the air of oxygen and nitrogen and substitute another gas for them, yes.

Q. And get complete shielding?

A. I would say complete replacement by another gas.

Q. That is what you had with the hand welder, was it not?

A. That is true, yes.

405 Q. So that if you had underneath the pile of flux complete gaseous shielding of the arc, you would not have holes in the weld, would you?

A. I haven't admitted what was under the flux, because I don't know.

Q. When you first started the operation under the Unionmelt flux, you stated that an arc formed?

A. Oh, yes, if you confine the statement to the very beginning, the initiation of the welding, then I would agree.

Q. Where did it go?

A. Where did what go?

Q. The arc. Did it disappear, or did it remain?

A. The phenomenon changes, and I most certainly do not understand the entire phenomenon.

Q. In each of these demonstrations, Mr. Kennedy, were you aware of where the ground was attached?

A. I was. It was attached to the center of the welding table. I think there were—I believe there were four leads in parallel from the transformers, and I am not sure, in the direct current setup, how many leads there were, but in every instance the ground was in the center of the table and on the back edge, that is, the edge of the table away from us.

Q. The table stretched the entire width of the dem-
406 onstration platform; that is what you mean?

A. That is correct. And the current was introduced into the table.

Q. Into the center of the table?

A. In the center of the edge away from us.

Q. So that I get this clear, as I faced the demonstration, that table was approximately what, 30 feet long?

A. Oh, I don't think it was any such length.

Q. 20 feet long?

A. I wouldn't judge it to be more than 15 feet.

Q. 15 feet long?

A. Yes.

Q. And the ground came into the center, about 7½ feet from each end if it were 15 feet, is that correct?

A. I would say that was right, yes.

Q. So that in the welding demonstrations that took place to the right of the center, you would be welding towards the ground, and the demonstrations that took place to the left of the center you would be welding away from the ground, is that correct?

A. Well, the matter of angularity would have to come into that. It would all depend on how wide the table is.

407 There is a vestige of truth in what you say.

Q. It would not be entirely the same as to each side of the table, would it, so far as the location of the ground and the direction of the weld is concerned?

A. There is a little element—or a little lack of symmetry in it, yes.

Q. The mere fact that the lines came into the center of the table and all welds were made in the same direction makes, in your opinion, only a little lack of symmetry?

A. Well, that little lack of symmetry might be of great significance in hand-welding. It certainly is not a significant in Unionmelt welding.

Q. It makes no difference which direction you weld from the grounds with Unionmelt?

A. Well, I have performed a good many experiments without being able to find out which way I ought to weld.

Q. The voltage used in the hand-welding and all the automatic welding was within the range of normal voltages for arc-welding, was it not?

A. It was; they were.

Q. What is the minimum voltage you have to have in order to maintain an arc, in electric welding, with a
408 metallic electrode?

A. I don't know that I know exactly. I think that it depends upon the nature of the electrodes, and I don't know the value.

Q. Have you ever been able to weld with a metallic electrode, with an arc, at any voltage less than 14 volts?

A. I have not heard of it being done.

Q. And all your experimental work in California was within the range of 15 to 50, was it not?

A. I think we have gone higher than that. I think we have been up to 70.

Q. But never below 15?

A. That is true.

Q. The fact of the matter is, you cannot maintain an arc below 15, is that not true?

A. I think that is generally recognized.

Q. And identical currents and voltages were used for the demonstration where you had both fluxes of the type, the Unionmelt to begin with and the clay flux second? The voltage and current recordings were the same throughout, were they not?

A. They were, because the current was determined by the transformer setting and the voltage was determined by the automatic control.

409 Q. And the automatic control is designed to maintain a uniform arc length, is it not?

A. It is designed to maintain a constant arc voltage.

410 Q. A constant arc voltage.

A. Any control has that for its function, to feed rod at such a rate that the voltage across the welding zone will be constant.

In the case of an ordinary arc, it is maintaining arc voltage constant. In our case, it is maintaining whatever we have under there, constant.

Q. But it operates in exactly the same manner; is that correct?

A. It operates in exactly the same manner, yes, sir, that is correct.

Q. Now you said that at Western Pipe and Steel, in your direct examination, you looked down on the welding operation from a distance of about four feet; is that correct?

A. That is, the operating platform was above—it was as though all of us were on an elevated platform, about two feet above the table, and we were looking down on the entire operation, rather than looking at it from the side, as we were in the demonstration room.

Q. You do not know the condition of the moisture content of the clay flux that was being used, do you?

A. No.

411 Q. That clay is inclined to pick up moisture, is it not?

A. I do not know as to that specific clay, that particular clay. All clay does, however.

Q. All clay does; that is a fact?

A. Yes.

Q. At Western Pipe, did they heat the clay first before they used it?

A. Generally.

Q. It was not done out here, was it?

A. I believe that it was not done in this particular operation, no, sir.

Mr. Stewart: That is all.

Redirect Examination.

Mr. Cahill: Mr. Kennedy, I desire to ask you a few questions on redirect examination, on the subject matter of your cross examination.

415 Mr. Cahill: Now, at page 295 of the transcript, Mr. Stewart asked you this question:

"Q. I mean, a satisfactory flux commercially, for your process, regardless of the cost."

Q. Now, I direct your attention first to the two qualifications contained in the question, "a satisfactory flux commercially", and secondly, "regardless of the cost."

Now, have you ever heard of any product being made commercially regardless of the cost?

A. Well, obviously the sentence is contradictory, because no commercial process is successful if you disregard the cost. I misunderstood Mr. Stewart because he

416 was turning towards one of his papers when he said "regardless of the cost", and I understood the purport of the question to be this: "Did you expect to use barium as a commercial flux?" To which the answer is "No" because barium is very expensive, and I did not realize that he had put that qualification in there, so my answer is that we did not expect to use barium as a commercial flux because it was too expensive, and calcium and magnesium are available all over the world, so our preference was naturally for the cheapest flux.

Q. Can barium silicate be used?

A. Yes.

Q. In practicing the patented process?

A. Yes. And we did. My memory is refreshed on what we did, because as I testified before, Jones was anxious

to find out whether barium could be introduced into weld metal, because when barium is in a weld metal it emits electrons very easily. In fact, there are spark plugs made that make use of that element in the metal in order that the spark will jump readily, so we made two or three passes and Jones cut the metal out with a cutting torch so we had a bar which was made under these circum-
417 stances, and he took it down to a forge plant and had it forged into a rod, and he expected ultimately to draw it into a wire, which I think he did not do.

Q. Well, as to the cost of barium silicate, in practicing your patented process, can you tell us whether or not the cost of barium silicate would be prohibitive, in your opinion?

A. Oh, yes. I do not have at my finger tips the cost of chemicals, but I am quite sure that it would be maybe 15 or 20 times as expensive.

Q. Now, I want to direct your attention to page 226 of the transcript where Mr. Stewart asked you a question.

"Q. You have in your experimentation used fluxes that have too high a melting point, have you not?

"A. We have.

"Q. They do not make very good welds, do they?

"A. Magnesium oxide was not useful."

When you made that answer did you refer to manganese or magnesium oxide by itself?

A. Yes.

Q. Or in combination with other elements or ingredients?

418 A. I referred to magnesium oxide by itself.

Q. Can magnesium oxide be included in the preparation of the silicate which can be used in practicing the process disclosed by your patent?

A. Oh, yes. If the reaction of magnesium oxide with silica is completed, then you have magnesium silicate; but magnesium oxide by itself has no use whatever.

Q. Now, you were asked about various combinations of compositions on your cross examination and I want to direct your attention to page 2 of your patent, lines 62 to 75, and—may I read it, your Honor, as preliminary to the question?

419 The Court: Proceed.

Mr. Cahill: "We have used calcium silicate and silicates of sodium, barium, iron, manganese, cobalt,

magnesium, nickel and aluminum, both in binary and ternary combination, in various proportions. We have also used calcium titanate and various titano-silicates, these being used when it is desired to introduce titanium into the weld metal. While a number of these conductive welding compositions are more or less efficacious in our process, we prefer to use silicates of the alkaline earth metals, such as calcium silicate, and we also prefer to add to these silicates minor proportions of alumina and of a substance adapted to lower the melting point, for example, a halide salt."

By Mr. Cahill:

Q. Now, directing your attention to that language, and having in mind the cross examination given to you as to these various compositions, will you tell us what is the minimum of efficacy, the least common denominator that these welding compositions must have in order to
420 practice the invention disclosed in your patent?

A. Well, each of them—or this factor is common to all of them, that a conductive melt is formed; that when an electrode is in contact with this conductive melt, metal will be deposited which is sound and good.

Q. Now, is there anything in regard to the immersion of the rod?

A. I meant to imply that when I said that the electrode is in contact with the liquid pool.

Q. Turning to how you and your co-inventors arrived at the proportions or percentages of ingredients, in the preparation of welding compositions, during your experimental tests, will you tell us how did you arrive at
421 such proportions or percentages of ingredients?

A. Well, we wrote the chemical reaction that we expected to take place and, having written the chemical reaction, the number of molecules and the weight of them is well known to chemists and well known as to how they combine. So we merely proportioned, on a large scale, what was told to us by the chemical reaction. The word stoichiometric appears in our patent, and that means you take the components you expect to have react and, after reaction has taken place, there is no excess of either component.

If you were going to form water, and you took so much hydrogen and so much oxygen, if there was no excess after

the reaction had taken place, then you would have a stoichiometric mixture of hydrogen and oxygen.

Q. Now, I want to direct your attention to some questions that were put to you at page 234:

"Q. At that time, during all the time you worked at the Western Pipe Company plant, you believed you had an electric arc-welding process, did you not?

"A. It was a matter of debate between the three
422 of us as to how the process worked.

"Q. There is not—

"Mr. Cahill: May he finish, please?

"The Witness: At one time maybe one of us would say, 'Well, maybe it is not an arc', and so forth. We were in doubt at that time."

Mr. Cahill: Now, did you make any tests at that time, namely when you were going through this experimentation at Western Pipe, in an effort to determine the nature of the phenomena present in the process disclosed in your invention?

The Witness: Yes, we did.

By Mr. Cahill:

Q. Are those tests recorded in your notes—

A. They are.

Q. —which have been marked in evidence?

A. They are.

Q. Now, Mr. Kennedy, you were asked a series of questions based on the applications for patent in this case, and you were asked questions as to whether you signed them or made an oath, and so on; and I want to put to you a couple of questions in that regard, and I will
423 ask you first whether, at the time you signed the first application for patent, all the statements contained therein were true to the best of your belief, based on the knowledge and information you had at the time you signed it.

A. Certainly. Any scientists worth their salt wouldn't sign anything they didn't believe.

Q. I repeat the same question with respect to the second application.

A. That applies to the second application.

Q. I give you the same question with respect to the third application.

A. And to the third.

Q. I want to ask you the direct question, whether at

any time, anywhere, any pressure or duress of any kind was used by any representative of Union Carbide or Linde Air Products, or any one of the subsidiary companies of Union Carbide, in connection with the signing of any papers by the inventors in this case, to be filed in the Patent Office.

A. There wasn't the slightest coercion.

Mr. Cahill: Now one final matter. Mr. Stewart read from a document, if your Honor please, to the Court, on cross examination, dated November 23, 1935, included 424 in the file wrapper marked in evidence here, and I should now like to read in that connection, very briefly, from the amendment dated November 2, 1934, filed with the Patent Office.

The document from which I read is the one that took the position that "our process does not depend on the formation of an arc of the usual type", and the paragraph that I will read is as follows,—and I am now quoting—:

"Applicants' specification has been slightly amended, where it discusses the theory of their process, and compares this process with prior art processes.

"It is immaterial to the patentability of the invention whether applicants are able to give the correct theory or not, but it is their purpose to give the Examiner the fullest information in their possession, on this matter.

"It is difficult, if not impossible, to define an arc precisely, and applicants have contemplated the possibility that a definition may be framed in such terms as to embrace the phenomenon which occurs in their 425 process.

"There can be no question, however, that there is no such arc involved in their process as occurs in every prior art process including that of Robinoff et al.

"Any one, if he bears in mind the intense dazzling arc which less than 50 amperes will evoke, and stands by one of applicants' machines and sees a weld made with 2,000 amperes, but with little or no visible evidence that a heating operation is being carried on, will quickly be convinced that here is something quite different from any arc-welding process known to the art."

That is the end of the quotation, and the end of the reading. That is all.

Recross Examination by Mr. Stewart.

Q. Mr. Kennedy, you stated that you were never under any coercion from anyone from Union Carbide, about anything to do with any of these patents —

Mr. Cahill: Just a moment, please. May I have that question read, or that statement.

426 The Court: Read the question.

(Question read.)

Mr. Stewart: I mean, applications.

Mr. Cahill: This patent?

Mr. Stewart: This patent, yes, or these applications. I am sorry.

By Mr. Stewart:

Q. That is correct, is it not?

A. Yes, sir.

Q. Did you see the covering letter that Mr. Cornwell sent to Mr. Hirst at the end of the month of December, 1933, which includes the second application for your signature?

A. I do not know that I did.

Q. I hand you, Mr. Kennedy, what has previously been marked in the deposition as Defendants' Exhibit 70, and ask you to read it.

427 Q. Will you read it to yourself first, then, please, Mr. Kennedy.

A. Yes, sir. (Witness reading document to himself.) I have read it.

Q. Do you recognize it as having been seen before by you?

A. I am quite sure that I did see it, yes, sir.

Q. This was shown to you, was it not, when the application was given to you by Mr. Hirst?

A. I actually do not remember being shown it, but

428 I cannot conceive of not being—of its being in Mr. Hirst's possession, and my not having seen it.

Q. At that time, whether you saw it or not, the following was brought to your attention, was it not,—and I am now reading from the third paragraph—:

"The enclosed application was prepared by Mr. Scheffler, and I feel that he has done an excellent job in the preparation, in view of the conditions.

"There was some question regarding the term that

should be used to cover the material called a flux in the previous application.

"Mr. Kennedy suggested that it be called a fused electrolite, but this did not meet with the approval of Mr. Becket.

"We considered the possibilities of calling it a conductive slag, or fused resistor, but it seemed advisable to call it a conductive melt, as the inventors are at liberty to define their own terms in a patent application."

—You recall that being told to you at that time, do you not?

A. Yes, sir.

Q. Quoting now from the last paragraph on page 1,
429 there appears the following:

"I have gone over all of the contained subject matter in the proposed application, with Mr. Becket, and he is entirely in accord with the manner in which the specification and claims have been drawn.

"It is quite possible that certain features of the specification may seem objectionable on the first reading, but these matters have all been carefully considered, and the general feeling is that it should be filed in its present form."

You had no objection to the form, I take it?

A. No, I don't think that we did.

430 Q. Now, Mr. Kennedy, going back to your testimony about the use of barium silicate, when was your recollection refreshed about your use of barium silicate in your experiments?

A. After I testified.

Q. And before your recollection was refreshed, this question was put to you and this answer given—

Mr. Cahill: The page, please?

Mr. Stewart: Page 295.

"Q. I mean, a satisfactory flux commercially for your process, regardless of the cost.

"A. Oh, I would say that it would not be useful,
431 nor did we think that it would be useful for the purposes of welding plates together."

Then the following question:

"Q. Barium is one of the three recognized alkaline earth metals, it is not?

"A. It is."

432 Q. All right, Mr. Kennedy, it is your intention today to say that since you did not hear the qualifying

statement "regardless of cost", that what you meant by your answer was that you did not think it would be useful for the purpose of welding together, because of its high cost? Is that what you mean today?

A. Naturally. That is quite natural.

433 That is all.

Mr. Cahill: I would like to offer the letter in full,

434 portions of which were just read into the record, in evidence.

Mr. Byron: No objection.

Mr. Cahill: That is the letter from Mr. Cornwell to Mr. Hirst, dated December 29, 1933.

The Court: Has it been given a number?

Mr. Cahill: No, it has not, your Honor. It will be 158 for identification, and it had a number on the deposition, 70 in parentheses.

Mr. Stewart: That was Defendants' Exhibit 70.

(PLAINTIFF'S EXHIBIT 158 was admitted in evidence.)

Mr. Cahill: I have no further questions.

(Witness excused.)

435 LLOYD THEODORE JONES, called as a witness on behalf of the plaintiff, having been first duly sworn, testified as follows:

Direct Examination by Mr. Cahill.

Q. Colonel, will you give your full name and address to the Reporter.

A. Lloyd Theodore Jones, 1812 Goldring Lane, Las Vegas, Nevada.

Q. Are you one of the patentees under the patent in suit?

A. I am.

Q. What is your education?

A. I graduated from Lake Forest College in 1909, majoring in physics. I remained an extra year as an instructor. I went down to the University of Illinois to continue graduate work in physics. I took a Ph.D. in 1915, then went to the University of California where I was in the physics department for some fourteen years.

Q. What did you do then, Colonel?

A. That would be about 1928. I believe 1928 was my last—

Q. Wasn't there some interruption of your service at the University of California in 1917?

436 A. Oh, I was a couple of years in the war.

Q. What did you do in the army?

A. I was in the Army Air Forces.

Q. As what?

A. Well, training as a pilot, and also in the gunnery training branch in the War Department in Washington, the last year of the war. Part of the time I was in charge of gunnery training for aviation in this country.

Q. Then did you thereafter do some confidential work for the United States Army in the year 1924?

A. In 1924 I went on duty as a reserve officer for three months at what is now Wright Field, and since I was always interested in engineering I took with me a problem in which I was concerned at the moment, an original problem, and wrote out for them the design of a mercury vapor turbine which would replace the Liberty motor in both dimensions and horsepower, and also in weight. For some reason I do not know, they called it confidential work.

Q. In 1926 did you write an article for Engineers Bulletin? I do not know the name of it.

A. Well, I had—I did.

Q. What was it on?

437 A. I believe the title was A Physical Study of the Welding of the Mokelumne Pipeline, published as an engineering bulletin by the University of Illinois.

Q. What was the Mokelumne Pipeline?

A. The Mokelumne Pipeline was a pipeline of steel some 88 miles long and 65 inches in diameter, half-inch plate, which extended from the Mokelumne River to the edge of Oakland and Berkeley, and which brought water from the Mokelumne River to the East Bay Municipal Utility District, which was the water district of all of those East Bay cities.

438 Q. Did you write any other papers on welding, Colonel?

A. A dozen or so. I had always been interested in welding for a number of years before that, and as a result, primarily, however, of the work that I did on the welding of the circumferential joints in the field, which joined the sections of pipe together, I wrote a dozen or more articles for various magazines on different phases, in order that the

industry, the steel industry, the oil industry and the water industry, all users of pipe lines, might learn that which I thought we had found about some unusual stresses in laying the pipe in the field by welding the joints.

I think all of the papers related to that type of welding, all except one.

Q. What was that one, Colonel?

A. Well, about 1927 I came in contact with Kennedy on an entirely different problem, a problem not related to welding; and in that problem, which involved a refrigerator car alteration for shipping commodities east, not related to welding, I became quite well acquainted with him. Either that fall or the next spring, which was '28, he and I were very greatly concerned with and interested in the de-
439 velopment of a flange weld, as we called it, for the girth weld of pipe lines in the field, and we carried out actual tests in full girth pipe up to thirty inches in diameter, carrying out the tests and publishing them in articles to show the conditions under which they would be successful.

It looked as though they were of lesser cost and a more modern method of welding in the field than what they had attempted with the acetylene welding of the circumferential joints in the Mokelumne line.

Q. You had taken your career up to 1928 when I deflected you about the papers. Will you pick up from 1928 the recital of your professional experience.

A. In 1928 I also published an article indirectly related to welding, which described a tapered pipe line for transmitting natural gas, whereas the pipe line increased in diameter as it leaves the source and approached the destination—increased in diameter in proportion to the reduction of pressure of the gas, the thickness of the steel also decreasing, the end effect being that, by installing such a pipe line for natural gas transmission, one could trans-
440 mit approximately 50 per cent more gas for a given weight of steel and a given cost of the welding of the joints of the pipe line.

Incidently, it used flange welding; so that the idea was partly to get across the flange welding, as well as to publish the equation which calculated the amount of gas transmitted.

In further demonstration of the flange weld, I believe it was also in 1928 that there was construction of a pipe line of about two or three hundred yards just above the Mokelumne Dam, in which the flange weld was used; and I have

personally made the welds on the circumferential field joints of that little bit of pipe line. It may—

Q. Colonel, —excuse me.

A. It may still be there, I am not sure.

Q. Will you carry your professional work up to the end of 1931 for us, please.

A. In 1929 I also was greatly interested in and did a lot of work in an industry not directly related to welding at all. It was the Neon tube and fluorescent tube industry, for the Electrical Products Corporation in Oakland.

I went over all the development of the Neon tube, no-
441 ticed that it could operate with an increased life, and then for them I also put in written form all of the data on fluorescent materials, what material you put together, how you make it and how you got it to fluoresce, and the conditions under which it fluoresces, and so forth.

That particular fluorescent part was in response to a request for information as to whether they should take a license under fluorescence in the general tube business. That was not related directly to welding. It involved things electrical, but not of a welding nature.

Q. Now, do you recall a conversation with a Mr. Delhi of Western Pipe and Steel, about the end of December, 1931?

A. I do. It was—

Q. I am just asking you, did you have such a conversation at that time?

A. I did.

442 Q. Now, prior to having had such conversation with Mr. Delhi, had you, and Rotermund, and Kennedy been engaged on any experimental work in connection with the art of welding?

A. Yes.

Q. And for how long a period had you been so engaged?

A. For several years. It was probably about 1927, although I might be in error by a year or more.

Q. And where had you been doing that work, that earlier work?

A. Part of it in Kennedy's shop, and part of it in the Electrical Engineering Laboratory; I believe only in those two places.

Q. What was that earlier work?

A. It was a little later than 1927, and it included the construction of an automatic feeder for bare wire welding rod, in order that the usual user of hand-welding by bare

wire could feed a three-foot rod, say, instead of a short rod, and if necessary, could feed it from a reel, instead of a three-foot rod.

Q. Now—

A. Pardon me; may I continue my answer to your question?

Q. Yes, if you will, please. I thought you had fin-
443 ished. I am sorry.

A. (Continuing.) The problem very quickly divided itself into two parts; one, for the hand welder, a three-foot rod, and one, for the reel, to feed wire from the reel, which took an additional automatic form, which resulted in a device about as large as a typewriter, which could crawl along the floor and which could weld as it progressed.

Q. Now, at the time when you saw Mr. Delhi, at or about December of 1931, did you have up with Mr. Delhi anything in regard to any earlier work that the three of you had done?

A. Yes, sir. I talked to Mr. Delhi, because we were very greatly interested in getting into contact with possible users, for sordid commercial reasons some of the devices in which we were interested, the devices feding bare wire for either hand-welding, or automatic bare arc-welding.

Q. Did Mr. Delhi tell you—or rather, first, did you have more than one conversation with Mr. Delhi at or about this time?

A. If that was before Christmas of 1931, yes, sir, I had more than a single conversation with him, within the month
following, which would make it possibly January of
444 1932, and it would be early in January of 1932.

Q. Did Mr. Delhi, in one of those subsequent conversations, at or about January of 1932, tell you that Western Pipe had a problem in connection with automatic electric welding?

A. Yes. As a matter of fact—

The Court: You have answered the question.

A. (Continuing)—I am sure it would be in the first conversation, because of the fact that the problem that they were having in connection with automatic welding on the Hetch-Hetchy pipeline, was uppermost in his mind.

By Mr. Cahill:

Q. I am not asking you what the problem was. I simply want to know, did he tell you they had a problem at that time?

445 A. He did.

Q. Now, did Mr. Delhi in that conversation mention to you the names of any individuals from whom he was going to ask help in solving that problem?

A. I don't remember that he did, in that particular conversation, no, sir.

Q. Well, did he at or about that time, or in some conversation at or about that time, mention to you the names of any individuals he had in mind asking help from in connection with this problem?

A. Either in that conversation, or in a conversation within the next couple of weeks or so, which would still be in January of 1932, he did tell me that there were three people, as he put it, in the United States, who he thought might be able to help them in their problem.

Q. Did he name those people to you?

A. Well, he was speaking to me as a general manager, to an individual, in conversation, to whom he wished to sell an idea, perhaps, which caused him to include my name among the three.

He mentioned that their problem was recognizably difficult, and that there was a Mr. Lester, at the Watertown
446 arsenal, and a Mr. Strobel, I believe in Los Angeles, and myself, and that the three of us—one of the three of us he thought might be capable of solving their difficulty.

Q. Had you heard of Mr. Strobel before, Colonel?

A. I am sure I had not.

Q. Colonel, there has been an exhibit put in here as Defendants' Exhibit No. 89, Articles of Agreement.

I wish you would look at that briefly, if you will, please. There is no need to read it through; just enough to let you answer the question, if you will.

Did you draw that paper?

A. I did.

Q. You are not a lawyer, are you, Colonel?

A. No, sir.

Q. Was that a proposed form of contract which you submitted to Western Pipe & Steel?

A. That was intended to consummate the effort which we had been making to reach an agreement with them.

Q. And it never was signed, was it, Colonel?

A. Oh, I signed this.

Q. But not by Western Pipe?

A. Oh, no.

Mr. Cahill: Now, if your Honor please, there are
447 just one or two further questions, and then I will be through.

If the Court please, my recollection is that we have marked the original agreement between Union Carbide Research Laboratories and these inventors in evidence. I am informed it is Defendants' Exhibit 90. Now, there are certain supplements thereto that I would like to mark at this time so we will have the complete story.

449 Mr. Cahill: At this time I will offer a letter signed by the Union Carbide & Carbon Research Laboratories by R. E. Cornwell, to Messrs. Jones, Kennedy and Rotermund, dated November 28, 1933.

By Mr. Cahill:

Q. Are you able to identify that as being a photostatic copy of what it purports to be?

A. I do.

Mr. Cahill: I offer it in evidence as Plaintiff's Exhibit 168.

Mr. Becker: 159.

Mr. Byron: Was there a former number on it?

450 Mr. Cahill: Not that I know of.

Mr. Stewart: It was one of a group of papers which was identified as Defendants' Exhibit 8 on the depositions.

Mr. Cahill: Let the record show it is one of a group of papers marked Defendants' Exhibit 8 on the depositions.

The Court: Is there any objection?

Mr. Stewart: No objection.

The Court: It may be admitted.

(Whereupon the said document was marked PLAINTIFF'S EXHIBIT 159 and received in evidence.)

By Mr. Cahill:

Q. I show you a letter from Union Carbide & Carbon Research Laboratories to you, Kennedy and Rotermund, dated March 26, 1941, and ask you if that is your signature appearing thereon?

A. It is.

Mr. Cahill: I offer it in evidence as Plaintiff's Exhibit 160.

The Court: Is there any objection?

Mr. Stewart: None.

The Court: It may be admitted.

451 (Whereupon the said document was marked PLAINTIFF'S EXHIBIT 160 and received in evidence.)

By Mr. Cahill:

Q. I show you a letter from the same firm dated February 25, 1942, and ask you if that is your signature, among others, appearing thereon?

A. It is.

Mr. Cahill: I offer it in evidence as Plaintiff's Exhibit No. 161.

Mr. Stewart: No objection.

The Court: It will be admitted.

(Whereupon the said document was marked PLAINTIFF'S EXHIBIT 161 and received in evidence.)

Mr. Stewart: We have no objection to any of these.

By Mr. Cahill:

Q. I show you an agreement bearing date November 20, 1944, and ask you if that is your signature appearing theeron, among others?

A. It is.

Mr. Cahill: I offer it in evidence as Plaintiff's Exhibit 162.

452 Mr. Stewart: No objection.

The Court: It may be admitted.

(Whereupon the said document was marked PLAINTIFF'S EXHIBIT 162 and received in evidence.)

Mr. Cahill: No further questions.

Mr. Stewart: No questions, your Honor.

The Court: You may step down.

(Witness excused.)

Mr. Wolfe: Dr. Doan, will you take the stand, please.

GILBERT E. DOAN, called as a witness on behalf of the plaintiff, having been first duly sworn, testified as follows:

Direct Examination by Mr. Wolfe.

Q. Will you give us your full name, please, Dr. Doan?

A. Gilbert E. Doan.

Q. Your residence?

A. Bethlehem, Pennsylvania.

Q. What is your occupation or profession?

A. I am professor of metallurgy at Lehigh University and head of the department of metallurgical engineering.

453 Q. What is the enrollment at Lehigh University?

A. About 3000 students today.

Q. How many in your department?

A. Oh, slightly over one hundred.

Q. Where is Lehigh University located, Dr. Doan?

A. In Bethlehem, Pennsylvania.

Q. How long have you been in the department of metallurgy there?

A. Since 1926.

Q. How long have you been head?

A. Since about 1939 or 1940.

Q. What has been your formal education?

A. I graduated in chemical engineering from Lehigh University in 1919 and in physical metallurgy at the University of Berlin, Germany, in 1927.

Q. What degree or degrees have you received?

A. Ch.E. and Ph.D.

Q. Have you studied the patent in suit and particularly those portions which deal with the welding process?

A. I have studied it carefully, especially the specification, and the material covering the process.

454 Q. Have you also studied the file wrapper and the contents of the application which matured in the patent in suit?

A. I have also studied the series of three applications.

Q. Have you had previous occasion to testify as an expert in a patent cause?

A. I have not.

Q. You have maintained your amateur standing up to the present time?

A. Yes, sir.

Q. What professional training and experience have you had in connection with electric-welding in general?

A. In 1919 and 1920 I was at the engineering experimental station at Annapolis in charge of tests of welding equipment which was submitted for Naval use at that time. From there I joined the Rail Welding and Bonding Company in Cleveland, Ohio as welding technician, and after spending a couple of years in that capacity I was service representative teaching welding crews how to weld in the principal cities of the United States and Canada.

In 1923 that company sent me to Germany to negotiate the purchase of a new welding development that had
455 come about there after the first World War.

At Lehigh University, after 1926, this interest continued, and most of my research endeavor was applied to the field of electric arc-welding, resulting in a number of studies and publications describing them in such periodicals as the American Institute of Electrical Engineers, American Society for Metals, American Institute of Mine and Metallurgical Engineers, and American Welding Society, and others.

Q. Have you published any books of a technical nature?

A. A textbook of The Principles of Physical Metallurgy.

Q. Were you also on one or more committees that wrote various chapters for this Welding Hand Book, for the American Welding Society?

A. Yes, I was.

Q. What societies or professional organizations of that kind are you a member of?

A. Oh, American Society for Metals, American Welding Society, American Institute of Mining and Metallurgical Engineers, American Society for Testing Materials, and American Association of University Professors, and—well, I don't remember them all.

456 Q. Did you and your associates receive an award for any of these papers that you have published?

A. Yes, sir.

Q. What was that?

A. The Lincoln Gold Medal.

A. In what year was that, Dr. Doan?

A. I believe 1943.

Q. And have you since that time had anything to do with awards of the Lincoln Gold Medal?

A. Yes. I am a member of the Committee of Awards of the American Welding Society, which awards the Adams Lectureship and the Lincoln Medal and the S. W. Miller Medal. I have been a member for three years.

Q. When was the award of the Lincoln Gold Medal first instituted, if you recall?

A. I believe it was 1937.

457 Q. Are you familiar with the Unionmelt welding process as it is used by licensees of the plaintiff in this case, in industry?

A. I am.

Q. What opportunity have you had to observe it?

A. I have given it careful study, both in the laboratory and in industry.

Q. What is the reputation among welding engineers of the performance capabilities of the Unionmelt process?

A. The reputation is for welds of quality not surpassed by any other welding process, and for a speed of welding not approachable by any other process.

Q. I have here a reprint of Chapter 7 from the 1942 edition of the Welding Hand Book, which chapter is entitled "Submerged Melt Welding". Are you familiar with the material in that chapter, Dr. Doan?

A. Yes, I am.

458 Mr. Wolfe: I would like to have this marked for identification as Plaintiff's Exhibit No. 163.

(Whereupon said document was marked Plaintiff's Exhibit No. 163 for identification.)

460 Q. Do you have a copy of the patent in suit there before you, Dr. Doan?

A. Yes, sir, I have.

461 Q. If you will look with me at the first page of the patent, the paragraph that begins on the last line of that page. The paragraph begins, "An object of the present invention is to avoid", and so on, and the paragraph continues, stating various objects of the invention, as you will see.

I will ask you to tell us, taking up each of those objects in turn, what the facts are as to the accomplishment of those objects, that is, whether or not they have been accomplished, and if so, in what manner, by the process which is described in this patent.

A. The section begins, "An object of the present invention is to avoid the disadvantageous features cited above, and to provide a process by which even thick plates can be strongly and rapidly electrically welded, * * *."

Before the development of this process, a weld even in quarter-inch plate would frequently—I should say usually—be made with two passages of the electrode over the joint. With the clay flux process, a half-inch thick plate was welded in a single passage of the electrode over the joint.

In the present process, a plate two inches thick can
462 be successfully welded with a single passage of the electrode over the joint, so that there has been a push-

ing upward of the previously inflexible boundary of thickness which could be welded in a single pass.

It says, furthermore, "with a weld of which the density and physical properties are at least equal to those of the parent metal."

The difficulty with arc welds which are essentially castings, is not lack of strength, because they are frequently stronger than the plates that they join, but their lack of plasticity, that is their ability to stretch plastically without cracking.

Plasticity may be considered as the opposite of brittleness.

Bare electric welds, at that time, and even today, have an elongation, elongation being the increase in length of a specimen up to the time it fractures and parts; the increase in length divided by the original length being called the percentage elongation, and being the measure of ductility.

Eight to ten per cent was very much lower than the ductility of the plates, which frequently were in the neigh-
463 borhood of 25 per cent.

With the development of the coated electrode, which incidentally was also a revolutionary development, this ductility increased up to 20 per cent, 25 per cent, and sometimes 30 per cent. In other words, the ductility became as good in the weld as it was in the plate itself.

Q. How do you people go about measuring this ductility that you speak of, doctor?

A. Why, I think that I have a tensile specimen there which shows the conditions adopted.

Q. Perhaps this is it.

464 A. This is a specimen which, in the case of a weld, would be made entirely of weld metal, and on which two punch marks are placed, separated usually by a distance of two inches. It is gripped in moving parts of a machine, and pulled until it is pulled apart. The stress or pull at which it breaks in pounds divided by the cross-sectional area at the beginning of the test is a measure of the tensile strength in pounds pull per square inch cross-sectional area. That is the strength measurement, and as I say, that was adequate in the earlier welds.

Here is another specimen of a smaller size maintaining the same proportions used where the weld is not large enough for the standard specimen. These, I believe, are

the broken pieces of a specimen after it has been—no. That is another specimen of a smaller size maintaining the same ratio, and here is still a smaller one for small welds in small tests.

Q. How do you measure this elongation or reduction in area you speak of?

A. When the specimen parts, it does so after considerable stretch or elongation has occurred in the test length. The two halves are then placed together and the distance between the punch marks measured at that time. The
465 increase in length between the punch marks is the measure of the amount of elongation which has occurred, and when that is divided by the original length it gives the percentage elongation.

Q. Did you give us the order of magnitude of those values in welds made with the process of the present patent?

A. In the process of the present patent elongations from 20 up to 38 per cent are obtained equal to, and in many cases superior to that of the plates joined, and not surpassed by any other welding process.

The third advantage, or objective, rather, outlined here is that heavier welding currents can be used and the rate of welding accelerated. In hand arc welding, with a three-sixteenths electrode, for instance, currents of approximately 300 amperes are customary. In the clay-flux process, I believe, the currents run up to six or seven hundred amperes. In this process currents up to 3,000 amperes are used successfully.

Q. When you say "this" you are referring to the patent in suit?

A. To the Jones process, yes, sir. So that the limits of current that can be used are of an entirely different
466 magnitude from anything that has been possible previously.

It goes on, "and the difficulty, especially in automatic machines, of reestablishing the arc when it has been extinguished." It also speaks there of arc instability, the instability of an electric arc, and its liability to be extinguished by a variety of adventitious causes.

Only those who have attempted to do arc-welding by hand are aware of the difficulty frequently encountered in arc blow due to magnetic currents principally, and often near the end of the member being welded or near a corner where you point the electrode at a certain spot which you

want to weld, the arc blows away from that spot. In this process that arc instability is considerably reduced.

467 Another object is to avoid the necessity for a flux sheath on the electrode. When an electrode has a flux sheath on it, it is impossible to feed current into it through that flux sheath, because it is an insulator, and that necessitates gripping it at the end, and consuming it as a stick, and when that is exhausted, another stick can be taken.

Other possible alternatives are to slit the coating and feed the current in through the slot, but that is only partly successful, because you then disturb the coating, and cause non-uniformity in the welds produced.

Those are the six objectives as stated at the beginning of the patent, and the statement of the extent to which they have been accomplished.

Mr. Wolfe: Before we leave that, if your Honor please, I would like to offer in evidence this group of test specimens here as Plaintiff's Exhibit No. 164.

Mr. Oberlin: Is it understood, may I inquire, that those are merely illustrative,—

Mr. Wolfe: They are merely illustrative.

Mr. Oberlin: (Continuing.)—and that they have no relation to any item which was produced either at the test

468 this morning, or otherwise, of like character.

Mr. Wolfe: Right.

The Court: Admitted.

(Whereupon said group of test specimens were thereupon marked Plaintiff's Exhibit No. 164 for identification.)

470 By Mr. Wolfe:

Q. Doctor, will you please explain for the Court what is referred to by you welding people as "porosity" in a weld.

A. Well sir, those are regions in which there has been gas, instead of metal.

Q. And do you find that in a variety of forms, in welds?

A. Yes, sir. It occurs, sometimes as spherical enclosures; sometimes as cylindrical enclosures; sometimes as small pin holes; and sometimes as large voids.

There are various ranges.

Q. And what is its significance in so far as the quality of the weld is concerned?

A. Well, in the first place, it reduces the metal available for supporting stresses.

In the second place, it may serve as nicks or notches, to promote easy failure.

It is very undesirable, in any event.

Q. Now, Doctor Doan, another matter in connection with the form of welds.

We have seen made some welds in which there was a pass on only one side of the pair of plates being joined in the butt weld.

471 Are butt welds also made in other forms?

A. Oh, yes, they are. They may be made in two passes, one pass on either side; or they may be made in many passes on one side, and one pass on the other side; sometimes, as a sealing bead.

Q. What governs the changes in those forms?

A. Why, primarily, the number of passes is determined by the amount of metal which they deposited per pass.

472 Q. How about the choice as to whether all the passes are made from just one side of the plates or from opposite sides?

A. Well, if they are all made from one side there is a danger that the weld may not penetrate completely to the bottom, thereby leaving a notch or an unwelded region which may promote stress concentration; or on the other hand, of melting through. It is difficult to limit the penetration to just the desired point.

Q. How are those dangers obviated?

A. They are obviated, in general, by putting at least one bead on one side to seal, as we say, the joint on that side, and make sure it is continuous there.

Q. And that reduces the care with which the depth of penetration must be adjusted in the other passes, does it?

A. It does.

Q. Dr. Doan, have you made any sample welds in accordance with the welding process that is described 473 in the patent in suit?

A. Yes, I have.

Q. Do you have some of those samples here?

A. Yes.

Q. Are these the ones to which you refer?

A. 63 and 81, yes.

Mr. Wolfe: I will ask that these two weld samples be marked for identification as Plaintiff's Exhibits 165 and 166.

(Whereupon the said articles were marked Plaintiff's Exhibits 165 and 166, respectively, for identification.)

By Mr. Wolfe:

Q. Referring, now, Dr. Doan, to this sample that has been marked Plaintiff's Exhibit 166 for identification, will you point out to the Court, please, the structure which appears there and say how that sample was prepared.

474 A. This shows the section cut through the weld, as well as the surface of it.

That particular one is in half-inch thick plate butted together.

The welding composition used in Unionmelt 20, 850 amperes, 28 volts, 15 inches per minute, of the electrode.

Mr. Stewart: If the Court please, I object to that. I don't know how he can tell by looking at the weld all that.

The Witness: I am looking at the data which I took at the time the weld was made.

Mr. Stewart: He didn't establish he was present.

Mr. Wolfe: He said he made these welds.

The Court: Proceed.

By Mr. Wolfe:

Q. And how about this Exhibit 165?

A. This one is in one-inch thick plate, made with the same welding composition, with 1550 amperes, 41 volts, 11 inches per minute.

475 I have recorded here that the burden depth was an inch and a half and the width about two and three-quarter inches.

Q. Now, how many passes were used in making those two welds of which you have produced samples?

A. They were made in a single pass, all the way through, single pass welds.

Q. On those samples, Dr. Doan, can you indicate for the Court the general outline of the groove which was in the edges of the plate before the weld was made? Perhaps you can mark it with a pencil on the sample itself, to indicate the general position.

A. No. X81 was a 60 degree included angle with the three-sixteenths nose. That is 81.

Mr. Wolfe: That is Exhibit 166.

The Witness: Something like that (Indicating).

Mr. Stewart: May I see it?

476 The Witness: I can't pick an angle out exactly. It was 60 degrees between, and the other one I believe was the same preparation.

477 By Mr. Wolfe:

Q. Now, in the marking which you have shown there, does the weld itself extend outside of your pencil marks?

A. Yes, sir.

Q. What would that indicate, or how would you describe that?

A. That indicates that the edges of the plates have been melted, and contributed to the weld.

Q. Can you say approximately what proportion of the metal in the weld is contributed by the plates, as compared to the contribution of the rod?

A. Well, there I think that my sketch has been inaccurate, because I know from measurements that from one-third to three-quarters, and sometimes more, of the weld metal comes from the plate edges; and the remaining one-third or one-quarter from the rod weld.

Q. And how does that ratio of contribution to the weld metal, compare with the contribution to the weld metal in, say, coated rod welding?

A. It is much larger, that is, in the coated rod, perhaps as much as 50 per cent; but usually less than 50 per cent comes from the plates.

Q. And how about bare rod welding?

A. There, even less, from the plates of the weld
478 metal.

Q. About what percentage is it?

A. Well, it would only be an estimate, but I would say that perhaps 25 per cent comes from the plates.

It will vary.

Mr. Wolfe: Now, I would like to turn to another subject, but before I do, I offer in evidence as Plaintiff's Exhibits 165 and 166 the weld samples previously marked for identification with those numbers.

Mr. Byron: No objection.

The Court: They may be admitted.

(And thereupon PLAINTIFF'S EXHIBITS 165 and 166 were admitted in evidence.)

Mr. Wolfe: Now, I would like to turn to another matter with you, Dr. Doan, in connection with this welding process of the patent.

We all saw the demonstration yesterday, of course, but we were not able to see what was going on underneath that granular layer. Now, I would like to put the question to you, first of all:

Q. Have you made any study of what it is that goes on under the granular layer of welding composition when
479 the process of the patent is being practiced?

A. I have made an extended study of it.

Q. Have you prepared a drawing by means of which you can illustrate what you have found goes on there?

A. Yes, I have, to simplify and clarify the presentation of those phenomena.

Q. Is this chart the drawing to which you refer?

A. Yes. That is it.

Mr. Wolfe: I will ask that it be marked for identification as Plaintiff's Exhibit No. 167.

(Whereupon said chart was marked Plaintiff's Exhibit No. 167 for identification.)

Mr. Wolfe: I have extra copies here for the Court and for opposing counsel.

Q. Will you point out first of all, Dr. Doan, what
480 the general layout of material is on this chart, Plaintiff's Exhibit No. 167, so we can orient ourselves here?

A. In the upper left is a reproduction from the Unionmelt apparatus catalogue, the 1945 edition, showing what we saw yesterday in operation.

In the lower left is a diagrammatic representation of the conditions under which the process is carried out, taken from the Welding Handbook, Figure 1, page 245.

In the center is a drawing which I made to show, as well as possible, the conditions in the interior of the process during its operation.

481 We see a slice cut through to the left of the electrode, showing the joint preparation, the bevelling of the plates and the butting of the plates prior to welding, with the flux piled up to fill the groove and the electrode projecting down into it.

On the extreme right of the central figure, Section BB, are shown the conditions after welding is completed.

You see represented there the once molten metal, which now constitutes the weld; above it the once molten welding composition, and on top the granular welding composition.

In the central figure we see the welding rod at the top projecting down into a pool of fused melt.

Now, in order to determine as closely as possible what the conditions are inside this zone, we found it very useful to drain out a weld of this kind while welding was going
482 on; and I think that would clarify the structure of this zone.

By Mr. Wolfe:

Q. Is this a sample of such a drained weld that you speak of?

A. Yes, it is.

Mr. Wolfe: I will ask that this specimen be marked for identification as Plaintiff's Exhibit 168.

(Whereupon said sample was marked Plaintiff's Exhibit 168 for identification.)

By Mr. Wolfe:

Q. Will you tell us, Dr. Doan, who made that specimen, Exhibit 168?

A. I made it, the operator operating the machine for it.

Q. Will you go ahead then and tell us how it was made?

483 A. It was made in two-inch plate, beveled with a 30-degree included angle, and with a current of 2400 amperes, alternating current, with a voltage of 42 volts, and the speed of advance of the welding rod along the joint was five and a half inches per minute, with a grade —20 Unionmelt, and so forth.

Underneath the joint was welded a one-inch plate, so that it would not melt through; but the one-inch plate was left short of the end of the joint so that, when the rod came opposite this position, it melted through and drained out the liquid, the liquid metal and the liquid melting composition that was in this crater.

Q. Now, let me see if I understand you correctly, Dr. Doan.

You said that you had two-inch plates there, and you were making a weld, a regular butt joint weld between the edges of those two-inch plates.

A. Yes.

Q. Is that right?

A. That is right.

Q. And that two-inch depth was being welded in a single pass, was it?

A. That is correct.

Q. And then when you came to the end of the underlying bar, did I correctly understand that it burned through?

484 A. Yes.

Q. So that all of the liquid drained out.

A. That is correct.

Q. When was the power shut off?

A. The power was shut off at the same instant that the first spark appeared underneath, the first globule.

Q. What was the size of the welding rod that was used?

A. A half-inch diameter.

Q. Now, will you with your pencil, please indicate for the Court what the location of the welding rod was at the time the fissure was drained?

A. Well, it was well up to the front here, almost at the front.

Q. All right.

A. In that position (Indicating).

Q. Now, will you go ahead, please, Dr. Doan, and point out to the Court what the shape and form of the fissure included there, shows, in relation to this drawing of yours on Plaintiff's Exhibit No. 167?

A. Well, that is the method which we used to arrive at a proper shape for the region marked "Fused steel" in the central drawing.

The slightly cross-hatched region was liquid welding; as you see, a very large volume of liquid metal.

485 Floating on top of that liquid metal was the granulated melt, the fused melt.

Behind this region, this hollow region, was solidified steel. The steel solidifies progressively inward from the walls.

Q. Why does it do that?

A. Because the heat flows out, through the cold walls, and therefore the crystals of metal grow inward, at right angles to the cooling surface.

Q. Does that have anything to do with the shape or location of the irregular little contour marks on the top of the weld itself?

A. Yes. These are what we might call isothermal lines which have moved inward, advanced, as heat has flowed out of the rear of those advancing lines.

Q. With that in mind as to the shape of this fused steel area that you have marked in your drawing here on Exhibit 167, will you go ahead, please, with your explanation of the showing on this drawing?

A. Well, the process operates in this way: Metal comes from the two plate edges which abut and form the rod itself. The liquid metal enters this pool of fused melt from those two locations. It is apparently churned up in the region immediately behind the electrode.

the metal mixing with the fused melt, and then in this pool behind the electrode separating due to differences in specific gravity, the fused melt floating to the top of the pool and the steel precipitating to the bottom.

That is the essential feature of this process. The electrode is immersed in a pool of fused welding composition. The metal passes from the electrode through that pool to the weld proper and the metal from the edges of the plates passes through that pool to the weld proper.

Q. What is the general shape of that pool? Can you point it out on the weld specimen there before you, Exhibit 168?

A. It occupies a region immediately behind and beneath the electrode, making contact with the electrode, and in that region perhaps of a cubic inch, perhaps a little more than a cubic inch, the metal is transferred from the tip of the electrode down through that pool and from the sides of the plate through that pool back to this reservoir of liquid metal which gradually solidifies.

This, if I may say it, is the essence of the process. It is a process for melting metal from a rod and from the plates and transferring that metal through a pool of fused composition to the reservoir which freezes as the electrode advances.

Q. Now, on your chart here, Exhibit 167, there is also an upper righthand section here marked "Conduction of electric current." Will you explain for us that aspect of the matter?

A. The figure at the upper right is an exact reproduction of the central figure, so that we won't have so many lines to caption. It points out merely that the rod and plate are in this position; that the terminals of an electric supply circuit are connected to the rods and plates.

The process applies the electric voltage, that is, a pressure tending to force current to pass from the rods to the plates. Then the granulated melt is in the position as we see on top of this pool, and we use enough granulated melt so that the pool will remain covered with granulated melt. This is a non-conductor of electricity, and the pool of melt is marked here.

The path of the current is as I have described; all of the electric current flowing between the rod and the plate passes through the pool of fused melt.

The entire pool is ionized. Now, that is a technical

term which means merely that the particles of which this fused melt is made up separate into individual particles carrying positive and negative charges. That separation occurs because of the high temperature. That is what is meant by ionization.

Q. Did you prepare a little booklet or memorandum on that subject, that is, in connection with ionization?

A. Yes, I did. It is called "Conduction of electric current in an ionized gas or liquid", and it describes the separation of these particles into positive and negative carriers because of the high temperature. That is, the high temperature causes this separation.

Mr. Wolfe: I might say, your Honor, that we have this little booklet prepared here just as a matter of convenience for the Court primarily, and I don't think there is anything controversial in it and I don't believe there is any necessity at the present time to go through it meticulously step by step.

Mr. Stewart: May we see it?

Mr. Wolfe: I hand opposing counsel copies.

Mr. Stewart: Is this handed to the Court before
489 we see whether there is anything controversial in it?

The Court: You may proceed.

Mr. Wolfe: I don't think that I need go into it yet.

By Mr. Wolfe:

Q. I interrupted you about this ionization matter, Dr. Doan. Will you go ahead with your explanation, please?

A. This entire pool is ionized because of the high temperature. These molecules are broken up into ions and free electrons bearing the electric charges which make up the current. In other words, the passage of the ions from the rods to the plates through the pool constitutes the flow of electricity, as we ordinarily speak of it. It is not a passage of the liquid through; it is the opposing flow of these carriers or ions.

The largest proportion of electric charges is borne by the more rapidly moving electrons in the core or inner portion of the pool, which is the hottest portion. The boundary or outer portion of the pool is made up of liquid fluid melt, which is more viscous or sticky and less conductive in the regions of contact with the granular melt.

490 As to the magnitude of the current, the electric current passing between the rod and the plate, is of

sufficient magnitude to maintain the conductivity of the pool of fused melt, and to fuse additional melt, and fuse the rod and the plate for coalescence with the same.

Q. Now, Dr. Doan, turning from this matter of the conduction of electric current, would you next explain for us what you have here under the caption "Fluid Movements" in the lower right-hand corner of this chart, Plaintiff's Exhibit No. 167.

A. As I have described this part of the process, it is stationary. Actually, as a matter of fact, of course, it is moving constantly at a rate of speed from six inches per minute, up to, maybe, two feet per minute; so that the dynamic consideration is important also.

I have made some tabulations here of the outstanding features of the fluid movements.

The tip of the rod fuses progressively, the resulting iron globules, vapor and mist mixing intimately with the fused melt.

The granular melt is fused at the front of this pool, by energy radiated from the pool itself.

491 Q. Do you mean, along this front border here, Doctor?

A. Yes.

Q. Where it is sort of "bellied-out" in your drawing here?

A. To the left of the rod is the front.

Q. Yes.

A. You see, the rod in this diagram is moving from right to left.

Q. Yes.

A. So that at the front, the granular melt is fused by contact with approaching fused melt, and sweeps downward across the floor of the crater.

The plate metal in the floor of the crater is progressively fused. The fused melt and the plate metal intermingle, and sweep rearward and upward in this turbulent region just behind the rod.

The fused melt then floats out of the molten steel, freezing on top of the weld, and leaving underlying weld metal of high density and chemical purity.

Any gas that is liberated in the float rises and escapes to the rear of the electrode; that is where the cooling commences.

The top portion of this pool which is marked here, rolls

forward in a tide following and touching the rod to
492 form a covering for the welding zone. In between the fused melt forms a circulating mantle—that might be a good way to describe it—a circulating mantle for the welding zone, between the rod and the plate. This mantle is viscous or sticky on its upper side where it is colder, and through the walls of this mantle the metal enters at the top from the rod and at the bottom and sides from the plate, emerging in the trailing tail portion of the mantle where the fused metal and melt separate due to their difference in specific gravity before solidifying.

Q. Returning for a moment to this matter of conduction of electric current that you discussed here a moment ago, can you refer us to some particular part or parts of the patent bearing on that subject?

A. Yes. I think it is described well on page, I think it is, 2, beginning with line 20:

"We have discovered a novel"—

Q. In the first column, is it?

A. The first column, yes.

"We have discovered a novel process for electric-welding wherein the necessary heat is generated by the passage of a heavy electric current between a metal
493 electrode (usually bare) and the metal plates or similar objects to be welded, the electrode being out of mechanical contact with the gap between the electrode and the objects by and through a conductive melt or welding composition having appropriate electrical resistance properties."

Mr. Wolfe: I offer in evidence as Plaintiff's Exhibit
167 the chart previously marked for identification with that number.

494 (Whereupon said chart marked PLAINTIFF'S EXHIBIT 167 was admitted in evidence.)

By Mr. Wolfe:

Q. In the course of discussing this operation, Dr. Doan, you have referred to immersion of the tip of the electrode in the pool of fused melt and to contact of the electrode with that pool. Will you tell us first of all whether or not you have made any particular investigation of that matter?

A. Yes, I have, approaching it from as many different conceptions as we could. I have also had some motion pictures made to show this condition.

Q. Will you outline briefly for the Court the various investigations that you have made along that line?

A. In the first place, one of the most direct evidences is simple visual observation of the welding process as it proceeds.

In the clay flux process we see a powerful stream of flame coming out from the welding region. That flame is entirely absent in this process, which led us to believe in the beginning that the electrode might be immersed,
495 but was by no means conclusive.

In the second place, we observed that the granular flux appeared to float on something. It did not fall down into the welding zone as the clay flux does. It appeared to float, and the bumping effect appeared to be the movement of a flexible—it appeared to be the movement of a liquid support under the granule material, which again is not conclusive in itself.

We noticed in addition that there was frequently a quiet flame like a candle flame surrounding the rod which any slight gust would blow out.

Q. Did you observe any such flame in the course of any of the demonstrations yesterday?

A. Yes. It was plainly visible.

Q. In which one?

A. I noticed it particularly in the Unionmelt weld in the one-inch plate. In addition to that the conditions at starting of this weld where the steel wool is used gives frequently some sparking and flashing, my interpretation being that the pool has not yet had time to form, sufficient granular material has not yet melted.

I have made some notes on this so I do not forget
496 it. We were by no means satisfied with looking at it, so we had an ordinary weld made by this process, and then using thin wooden strips we scraped away this superincumbent burden of granular flux.

Q. That is this part marked here in your drawing, 167, as the granulated melt, that sort of sandy looking stuff?

A. That is right. We scraped it away in order to see what was underneath it, and we found that as we scraped it away we would reveal a liquid layer, and that if we scraped a little too much we broke that liquid layer and a puff of gas would come out indicating that the gas had been sealed in there by complete immersion of the electrode, and that it came out only when we broke it.

497 We tried a great many other tests. We tried using, instead of the normal burden in which the pool would be completely supplied with granular material and completely obscured, we tried using a thin burden where we would be right on the edge between an exposed pool and a covered pool, with as little covering as possible; and under those conditions again we could see—and the motion pictures which I had made will show—contact of the pool with the electrode, immersion in the pool of the electrode. There are a good many more. We thought we would advance into the thing gradually, so instead of a burden of flux of uniform depth, we used a burden which was tapered, and which began with practically no flux, an open arc of the old type, and advanced that into deeper and deeper layers of flux. We could see, under those conditions, the molten flux outside of the arc, and then as we advanced into deeper layers, this tide of flux becoming deeper would come closer and closer to the rod until, at a certain depth, it enclosed the rod completely and immersed the end of the rod in the pool. I think we have some movies also showing that gradual transition.

Q. And what did you find happened in the weld at 498 that transition point, from open arc to immersion?

A. We found that when the open arc existed, even with the flux under it in substantial layers, that when the open arc changed to a transfer through the pool, the character of the weld changed abruptly. At this end, in the open arc, it was porous; as soon as enclosure was complete a sound weld resulted.

Q. You have the specifications of that here, too, do you?

A. Yes; yes.

Q. Well, we will take those up when you have finished your cataloguing of the various investigations you have made.

A. Now, another idea occurred to us, that if this electrode were immersed in a pool, and then if we could use a hollow electrode, and blow a gas down into the pool, we ought to be able to blow a bubble; and so we did use a hollow electrode, which I think was five-sixteenths of an inch in diameter, and blew an inert gas down into the pool, which I think was argon, which would not react with the hot metal. We blew that down into the pool, and measured the pressure that the pool would sustain before it burst. In other words, we measured the strength of the

pool, and we found that under ordinary circumstances
499 we would get a back-pressure of something like 10 millimeters of mercury; and that we had to increase that pressure to about 40 millimeters before we would blow out the pool.

You see, if that gas could have escaped, say, up around the sides of the electrode, or at some other point of the weld, the pressure would not have risen, but the seal of the pool to the electrode was complete, and the pressure did build up until a blowout occurred.

We approached it from some other angles, or directions, also, as a matter of fact from a great many others, not all of which were conclusive to us, and not all of which were free from objection.

Finally, however, we said, "If this welding operation does take place with the rod immersed in a liquid pool, then let us produce a pool of liquid welding composition, pre-melted, and pour it into a trough with firebrick sides, and then weld down through, without any granular material on top at all, and if that is not what occurs in the actual process, then we ought to be able to observe some differences."

We connected an oscillograph to the normal process
and to this pre-melted flux, and we found no differ-
500 ence.

We observed the appearance of the melted flux during the welding, and found no difference from what we saw in the scrape-away tests.

We examined the weld which was produced, and found no fundamental difference.

So, having approached it from a great many different angles, and with this final confirmatory test, we said, "There is not any doubt left in our minds about the mechanism of this process."

Mr. Wolfe: Now, if we may have that weld specimen, please.

We have here a weld specimen which I will ask the reporter at this time to mark as Plaintiff's Exhibit No. 169 for identification.

(Whereupon the said article was marked Plaintiff's Exhibit 169 for identification.)

By Mr. Wolfe:

501 Q. Who made this specimen, Dr. Doan, Plaintiff's Exhibit No. 169 for identification?

A. I did.

Q. Will you please tell the Court, just very briefly, how it was made?

A. Well, this was one of the methods of ascertaining whether or not the electrode is immersed in a pool. At this end of the specimen (Indicating to the Court) we started with no welding composition—

Q. Now, just a moment right there, please, Doctor. Let us get the record straight, as to which end you are talking about now. You are facing the polished edge of the specimen, and are pointing to the lefthand end as you face it, as being the starting end.

A. Yes.

Q. Is that correct?

A. Yes, sir. The specimen is marked X-133.

Q. Continue.

A. We began at this end (indicating) with a very thin layer of welding composition, and a deeper burden, increasing to the other end, up to a very heavy burden.

We continued welding along here, up to this point (indicating), observing the electrode continuously as it
502 progressed, until, at a point somewhere near midway of the plate we observed that the flux tide closed in and sealed the electrode.

We recorded that point independently, just to check each other. I have recorded here, I believe, what the depth was at that point. The surface of the weld changes from bad to good at the middle of the plate, after six inches of the half-inch deep burden has been traversed.

That was before it was cut, because you can see that the surface is considerably porous until the electrode is immersed in the pool, and after that you get a sound weld.
503 Q. Did you make any further, similar tests to check that sharp transition from porous to sound weld, coincident with the tests you have mentioned?

A. Oh, we made a considerable number of them. Of course, this might be just a fluke.

Q. Now, you speak of some motion pictures that you had made, Dr. Doan. Will you tell us in general what those were, the various ones.

A. Well, I think the most interesting one, to begin with, so that everyone can follow along, is one in a two-inch thick plate similar to the one we had here a minute ago.

Q. In the case of the particular motion picture, were you present personally while it was taken?

A. I don't believe I was for this one of which we have movies.

Q. Have you witnessed welds made in a tow-inch plate?

A. Yes, a number of them.

Q. And did you get any directions for the making of this particular movie of the two-inch plate?

A. Yes, I did. We made a number of such tests, and when we found that the conditions were satisfactory I wanted a motion picture made; but I think when this one was made I was not there.

504 Mr. Wolfe: Now, if the Court please, if the Defendant has any objection we should be glad to withdraw this witness for a few minutes and produce the man who did make the run at the time the picture was made.

Mr. Byron: Yes; we will make the same objection we made yesterday in that regard.

Mr. Wolfe: I would like to withdraw this witness, then.

The Court: Any objection to withdrawing this witness for that purpose?

Mr. Byron: No.

The Court: All right, you may do so.

(Witness temporarily withdrawn.)

505 EDWIN A. CLAPP, called as a witness on behalf of the plaintiff, having first been duly sworn, was examined and testified as follows:

Direct Examination by Mr. Wolfe.

Q. Will you give your full name, please, Mr. Clapp?

A. Edwin A. Clapp.

Q. What is yor residence?

A. Niagara Falls, New York.

Q. What is your age?

A. Forty-five.

Q. What is your present employment?

A. I supervise the activities of the Unionmelt Laboratory at the Union Carbide and Carbon Research Laboratories.

Q. In what place?

A. Niagara Falls, New York.

Q. How long have you held that position?
A. Since 1934.
Q. How long have you been employed by Union Carbide Corporation, or one of its subsidiaries?
A. Since late 1924.
Q. What, in general, has been the character of your work throughout that time?
506 A. Research almost entirely, all but the first two or three years; chemical engineering, metallurgical research and welding research.
Q. What experience have you had, if any, with automatic welding?
A. It has been confined solely to the process of the Jones Patent.
Q. Did you receive any instructions from Dr. Doan for preparation of motion pictures?
A. Yes, I did.
Q. What were the instructions, in general?
A. To make a two-inch plate weld, single Vee, at approximately 2900 amperes, with the melt burden so adjusted that the contact between the rod and the fused pool of welding composition would be visible.
Q. Did you make such a weld?
A. Yes. I actually made several of them.
Q. Was a motion picture of it taken in your presence—
A. Yes.
Q. —while you were making the weld?
A. Yes it was.
Q. Can you identify this reel of motion pictures that I hand you?
A. Yes.
Q. What is that?
507 A. It is a motion picture of weld No. 400-A.
Q. Can you say whether or not that is the one to which you referred as having made pursuant to Dr. Doan's instructions?
A. I believe so. I have some notes with me that cover that particular weld. Yes. Weld 400-A was the first half of Weld 400, made at 2900 amperes, 41 volts, with a speed of 5½ inches per minute, in two-inch plate prepared with a 30-degree Vee, and one-eighth inch grooved face backed by one-eighth inch thick steel bar.
The weld was made with one-half inch rod and the melt burden was adjusted to approximately two inches.

Q. Where was that weld made and the picture taken?

A. It was made in the Union Carbide and Carbon Research Laboratory at Niagara Falls in the Unionmelt Building.

Q. When was it made?

A. It was made approximately a month ago. I do not recall the exact date.

Q. At what speed was the film exposed?

A. At 24 frames per second.

Q. And what sort of film was used?

A. Kodochrome, the color film.

508 Q. Have you seen this film projected?

A. Yes, I have.

Q. What do you have to say as to whether or not it accurately depicts the welding operation of which it was taken?

A. In my opinion it accurately depicts the welding action as I saw it.

Mr. Wolfe: I offer the reel in evidence as Plaintiff's Exhibit 170.

The Court: It may be admitted.

(Whereupon the reel was marked PLAINTIFF'S EXHIBIT 170 and admitted in evidence.)

Mr. Wolfe: That is all, your Honor.

The Court: Do you want to cross-examine?

Mr. Stewart: Just two or three questions, your Honor.

Cross-Examination by Mr. Stewart.

Q. Mr. Clapp, did you take more than one film?

A. Yes, I believe there were two or three films taken, but this particular film is the one that depicts the action that we wished to show, in that it was necessary to adjust the melt burden to disclose the contact that exists between the rod and the fluid flux.

509 Q. The other films showed something different, is that correct?

A. No, they simply failed to show the contact, inasmuch as the melt burden wasn't properly adjusted. In other words, the action was obscure. We had no way of knowing beforehand what we would get.

Q. Did they show some very visible arc flashes?

A. No.

Q. In no case?

A. In no case.

Q. 2900 amperes is very unusual current in this process, is it not?

A. No, it is not. I have welded higher.

Q. Commercially?

A. Yes. No, I haven't commercially, but higher currents have been used.

Mr. Stewart: That is all.

(Witness excused.)

Mr. Wolfe: Now, if the Court please, we would like to project these films here, and they have been arranged in one set of four or five frames cut out from the films, so that they can be projected preliminarily here with a slide projector; and I will ask Dr. Doan to point out in those the various elements that appear, so that we can
510 be oriented for viewing the motion picture.

(And thereupon a projector was set up in the court room for the purpose of exhibiting motion pictures.)

GILBERT E. DOAN, called as a witness on behalf of the Plaintiff, having been previously duly sworn, resumed the stand and testified further as follows:

Direct Examination by Mr. Wolfe (Continued).

Q. Now, Mr. Doan, will you step down here and point out what appears here in this projected film.

A. Above here is the feeding head which feeds the rod down. This is the rod (indicating) being fed down into the granular flux, in front as you see, and behind you see the pool in this thin burden or shallow burden of molten flux, in contact with the electrode and, in fact, at this
511 particular instant, flashing up the side of the electrode.

Q. Which way is the electrode traveling?

A. The electrode is traveling from right to left, advancing into the granular flux.

Ordinarily, of course, this pool would be covered with additional granular flux, and therefore not visible; but in this thin burden, it becomes visible.

Q. Will you just point out on these other views here any particular items which you note.

A. I see nothing new particularly in this one. It shows again the rod in contact with the pool of molten flux com

position, and the head of the rod in the granular material.

These are the particular views in the motion picture reel which will follow, to which we want to pay particular attention.

This is a spill out of the molten flux caught at that instant. Here again is the rod immersed in this pool of fused welding composition, and ahead of the advancing rod the granular material, which will later be melted and form part of the pool.

This view shows substantially the same situation.

Mr. Wolfe: All right, I think we can run the full
512 motion picture now, if you will set up the other projector.

(Set projector was set up.)

513 Mr. Wolfe: All right, Dr. Doan; if you will stand over here by the screen perhaps you can point out to the Court various items as the motion picture is projected.

(The projection of the moving picture was thereupon commenced.)

The Witness: You see here we are right on the edge of an insufficient melt burden, but you see the pool nearly in contact, and you see the electrode feeding down and those narrow marks showing how rapidly it is feeding in. You see the contact with the pool very clearly. In other instances the granular material covers it up.

Now, here the pool at the front of the electrode is not as large as it is, of course, at the rear where it has already been heated, but the radiant energy from the welding zone does melt the granular flux material ahead of the welding zone.

Right here the burden was a little too deep. It is covered over partly, and here is some of this material near the welding head, the molten composition.

514 That is the quiet flame, that flame I mentioned before. You see it occasionally here.

Here you can see the contact very clearly, the rod being immersed as it is fed through the pool. Here the pool is breaking out to the rear of the rod.

(The projection of the moving picture was thereupon concluded, and the witness resumed the witness stand.)

By Mr. Wolfe:

Q. Dr. Doan, I believe you also mentioned some other motion pictures that you had taken, along this same line. Is that correct?

A. Yes, we took some high-speed colored motion pictures, some of them in the transition, or the closing-in stage, of the tapered burden also.

Q. And were you personally present at the time those were taken?

A. Yes.

Q. Now, Dr. Doan, can you say whether or not this reel which I hand you is the reel to which you have just referred?

(Handing motion picture reel to witness.)

A. I would be able to say very much better when I see it.

515 Q. You can unroll the end there, if you wish, Doctor, and take a look at some of the frames through the light, just in order to verify that.

A. Oh, yes, that is correct; this is one of the reels that were taken.

Q. Where was that taken?

A. At Niagara Falls.

Q. Can you tell us when?

A. Well—

Q. At least, to the best of your recollection.

A. I think that it was taken in October.

Q. Of 1946?

A. Yes, sir—this year.

Q. 1946?

A. Yes, sir.

Q. Will you please tell us what the conditions of welding were under which these pictures were taken,—the Unionmelt welding?

A. Is this reel No. 1?

Q. That is the Unionmelt reel, Doctor. I have forgotten just what number it bears in your series, however.

A. This was on one-inch plate, with the standard Unionmelt bevel; a current of 1550 amperes, 41 volts, with 11 inches per minute of travel speed, grade-20 Unionmelt, one inch burden only.

This is a light burden condition again, to show the 516 immersion of the rod, a five-sixteenths of an inch rod.

Q. What do you have to say as to whether or not—well, strike that out.

Have you seen this roll of films projected?

A. Yes.

Q. What do you have to say as to whether or not it

accurately depicts the welding conditions under which it was taken?

A. It records them accurately in so far as any motion pictures that we have been able to get record them accurately.

It is much easier to see it, of course, than it is to record it.

Mr. Wolfe: I offer this roll of film in evidence, if your Honor please, as Plaintiff's Exhibit No. 171.

The Court: Admitted.

(Whereupon the said reel was marked PLAINTIFF'S EXHIBIT 171 and was received in evidence.)

Mr. Wolfe: Now, may we have this projected in
517 the same manner. There is here, again, a leader of a few frames, to be put on the still projector.

(Thereupon the showing of the pictures was commenced.)

Mr. Wolfe: Now, Dr. Doan, will you please point out the parts that appear there.

The Witness: This is the electrode, the rod, immersed at its lower end in a pool of molten welding composition, and at this particular instant some of that molten pool is erupting along the side of the rod.

The blue light that you observe here is transmitted through the translucent flux composition, and I have some of that flux composition with me here at this time, which I would like to show, so that everyone can see its ability to transmit light.

Mr. Wolfe: Next frame.

The Witness: This one, of course, is just an instant before or after the previous one, and shows the same condition.

518 Mr. Wolfe: Next frame.

The Witness: This one shows perhaps a little more of the pool. Otherwise nothing new.

Mr. Wolfe: Next frame.

The Witness: This again shows just the instant at which the pool is erupting.

Mr. Wolfe: Next frame.

The Witness: That is the same thing, essentially.

(The showing of still pictures was thereupon concluded.)

Mr. Wolfe: We have another reel of moving pictures to be projected. Now, Dr. Doan, as this film is projected, will you point out the particular items we should note here, please.

(The projection of the motion picture was thereupon commenced.)

The Witness: This is an example of scraping away the superincumbent layer of granular material to reveal the pool underneath the granular material.

You see the electrode immersed in this pool and the bubbling action that I referred to.

This, of course, is with the thin burden where the
519 pool is about to break out any instant, and does frequently break out, but there can be no doubt, it seems to me, about the immersion of the electrode in the pool.

That is the quiet flame that you see occasionally, that I spoke of.

(The projection of the motion picture was thereupon concluded.)

Mr. Wolfe: We have another reel.

(The projecton of the motion picture was thereupon commenced.)

The Witness: This is a high-speed motion picture so the action will be easier to follow, again with a light burden so that frequent breakouts occur. Nevertheless, the immersion of the rod in the pool is easy to see. The stills may have come from just such a series of pictures as this.

520 This is, in my opinion, the essential feature of the process, the immersing of the electrode in the pool.

The light by which this picture is taken is the light from the welding zone itself, so when the pool is covered with granular flux there is no light and, therefore, no picture.

These blow-outs would not occur under normal operations, because the pool is deeper due to a deeper layer of granular material.

Mr. Byron: That is all argument.

(The showing of the motion pictures being concluded, the witness resumed the stand.)

By Mr. Wolfe:

Q. Dr. Doan, a little while ago this morning you called our attention to the first part of the paragraph in the patent which begins at line 20 on the second page, column 1. That paragraph continued:

"The heat thus generated melts successive portions of the electrode and the molten material is deposited as weld filler material. The welding composition serves as an ac-

tive instrumentality, or welding medium, inasmuch as it provides heating means, controls the rate, penetra-
521 tion, and quality of welding, purifies the molten metal, and protects the molten metal."

Now, as to each of those several items there, such as providing heating means, controlling the rate, and so on, I wish you would state to the Court how it is that the melting composition here accomplishes those various purposes.

A. It provides heating means in that the carriers of electricity, upon arriving at the electrodes, give up their energy in the form of heat and, as any conductor of this type, produce heat by the passage of the current through them.

Now, all of the current passes from the electrode to the plates through this pool; and it is in the passage of the current through the pool that the heat is generated.

Q. And in a phenomenon of that kind, what is the ratio of conversion of the electric energy into heat energy?

A. 100 per cent.

Q. Now, the next item here, after Heating Means, is that welding composition controls rate and penetration of the weld.

What information can you give the Court about that?

A. The addition of calcium fluoride to the welding
522 composition changes substantially the penetration for a given set of welding conditions.

Q. Do you have some welding samples which you made, by which you can illustrate that, Doctor?

A. Yes, sir, I have. I believe that those are X-120 and X-121.

Q. Are these the samples to which you refer?

(Handing to witness.)

A. Yes.

Mr. Wolfe: I will ask that these be marked for identification as Plaintiff's Exhibits 172-A and 172-B, please.

Mr. Stewart: Pardon me. The top one is 172-A, is it?

Mr. Wolfe: Yes.

(Whereupon said weld samples were marked Plaintiff's Exhibits 172-A and 172-B for identification.)

By Mr. Wolfe:

Q. Now, Dr. Doan, will you please state what welding conditions were used, in preparing those two samples, Plaintiff's Exhibits 172-A and 172-B.

A. Well, sample 172-A was prepared with half-inch plate, using Unionmelt Grade 20, with an inch and a quarter burden in this instance; 850 amperes, 28 volts; 16
523 inches per minute; with a quarter-inch rod.

Q. And what were the conditions with respect to the other sample, Plaintiff's Exhibit 172-B?

A. This other one was prepared under the same conditions, with the same plate material, with the calcium fluoride omitted from the Grade 20 Unionmelt.

Q. And what difference if any does that cause in the welds, as shown by those specimens?

A. Well, the omission of the calcium fluoride was given a narrower weld.

Q. Has there been any effect on the penetration there, Doctor?

A. The one without the calcium fluoride has a great deal more penetration.

524 Q. And by "penetration" you mean what?

A. Depth of melting down into the joint.

Q. Now, the same portion of the patent to which we were referring continues, saying in effect that the welding composition controls the quality of welding, purifies the molten metal, and protects the molten metal. Will you tell us how it serves in those capacities?

A. It controls the quality by purifying and protecting it, and the purification is by dissolving out of the liquefied steel some of the impurities which it contained. That, I suppose, strictly speaking would be the fluxing action of this material, but it is very minor in its contribution.

The protective action is, on the contrary, of the very greatest importance because we must remember that this welding process involves the melting of metal at the electrode and the transfer of that molten metal in the old processes through the air where it is subject to very rapid burning and oxidation.

If material is finely divided—take, for instance, the flour in a flour mill, or the coal dust in a mine—those finely divided particles oxidize with great rapidity. They
525 oxidize with explosive rapidity when finely divided.

Some of this material that passes from the electrode to the weld is in that same finely divided state, and all of it is in a relatively fine state of subdivision. Likewise the material melted in the plate edges melts in the form of thin film, and because of their thinness a great deal of surface is

exposed per unit volume of material, so that it is a very difficult task to melt and transfer this material from these two positions, the electrode and the plate, into the weld proper; and when we realize that that material is highly superheated above its melting point and that the rate of oxidation increases very rapidly with the temperature, we see that with those two factors, fine subdivision and high temperature, oxidation can occur very readily.

The protective action which the welding composition exercises is protection against contamination and injury of this molten metal during its transfer to the place where it is used, and that action is again the purpose, the most essential purpose of the welding process; that is, the melting, transferring and positioning of metal.

Q. Well, what part does this pool which you have
526 spoken of play in the action, if any?

A. It completely excludes air, oxygen and nitrogen, from access to the metal in this delicate transfer.

Q. How does the purity of the weld metal produced by the process of this patent compare with that of other processes?

A. Its purity is brought out most clearly by its high ductility. As I have said, the ductility of the weld metal produced is not surpassed by any other welding process, and it is frequently much higher, very much higher than—

Mr. Byron: So far as you know.

The Witness: So far as I know.

By Mr. Wolfe:

Q. Have you made an examination of the crystalline structure in the weld specimens that you have produced with this process?

A. Yes, I have.

Q. What did you find in that?

A. The structure is that of columnar grain such as we find in an ingot, that is, a casting, a steel casting.

Some of those larger specimens that we had here this morning show it better, although it can be seen in
527 these. This columnar structure is in general accompanied by low ductility, and therefore in a joint of this kind such a structure is undesirable.

A metallurgist unacquainted with the process, looking at that structure, would say, "I think that will be relatively brittle and low in ductility." When the metal is tested, it

is found to be very high in ductility, in spite of its structure. Its high ductility I believe we must attribute to its purity and freedom from foreign inclusion.

Q. Do you know of a parallel elsewhere in metallurgy of a columnar structure such as you have spoken of accompanied with the high ductility you have spoken of here?

A. I do not.

528 Mr. Wolfe: Does the Court care to suspend at this time, your Honor?

The Court: No; I think that we can very well run for a few more minutes. However, I would like to have an explanation of something. I would like to have the witness tell me what oxidation is.

The Witness: Oxidation?

The Court: Yes.

The Witness: Oxidation is a combination of oxygen with a solid material—that is, with a solid, liquid or gaseous material, forming oxide. It is the process that is involved in the burning of coal, or the burning of gasoline.

In this particular instance it is iron—or rather, to be specific, it is steel that is burned; that is, it takes on oxygen in the form, in this case, of iron oxide, and that iron oxide is soluble in the steel at a high temperature, and insoluble in the steel at a low temperature; so that, upon cooling, this oxide gradually precipitates out, comes out, separates from the steel within it, separates in tiny segregated portions in the steel.

529 That phenomenon is called age hardening, and causes the brittleness that I have spoken of in welds made where air has access to the steel in transfer, like the old open arc bare rod process.

Nitrogen acts in much the same way. Air is made up of 80 per cent nitrogen and 20 per cent oxygen, and both of them contact the liquid material, and combine with it, and dissolve in it, and injure its properties, so that, with ordinary bare electrode welding, the stretch or plasticity, or ductility of the metal is from 8 to 10 per cent, whereas, in this process, it is from 20 to 38 and 40 per cent, a very large improvement, certainly, in engineering structures; all arising from the reaction of air with the hot liquid steel in a finely divided condition.

By Mr. Wolfe:

Q. Now, to be sure that that is entirely clear, Doctor, do you mean that the improvement here comes from the reaction with air, or the prevention of reaction with air?

A. From the prevention of reaction with air, or protection, in other words, of the weld metal.

530 Q. Now, Dr. Doan, I would like to take up with you another aspect of this matter.

There have been mentioned throughout the case here some former arc welding processes, that is, with a bare rod, and with a coated rod, and clay flux, which are also set out on the first page of the patent here in suit.

Now I wish that you would compare or contrast for us, in a point-by-point manner, giving us the facts, those processes which I have mentioned, that is, the bare rod arc, the coated rod arc-welding process, and the clay flux process, with that of the patent in suit.

Do you have some drawing or chart in that connection?

A. Yes, sir. I have, for the sake of brevity and 531 clarity, set down here again a drawing of the essential features of the process, and have contrasted those with the welding processes before this one was adopted.

Mr. Wolfe: I will ask that this chart be marked as Plaintiff's Exhibit No. 173 for identification.

(Whereupon said chart was marked Plaintiff's Exhibit No. 173 for identification.)

By Mr. Wolfe:

Q. Now, Dr. Doan, I wish you would point out generally the arrangement here on the chart of the material which you have presented.

A. On the left, in the upper Figure, is shown a bare electrode process, taken from the Welding Handbook. The welding rod is shown at the left, and above. The molten material is shown beneath and behind it. The rod is moving from right to left.

You see the open arc flame, similar to the one which we observed yesterday. You will note, the surprising thing is that this bare electrode arc-welding process worked at all. We simply picked up the welding rod, back about 1880 or 1890, and welded with it. The transfer of the metal from the rod to the weld occurred through the air, and the 532 contamination by the air gave the low ductility and brittle properties, 8 to 10 per cent elongation, that we know were typical.

About 1927 this rod was coated with materials which form a blanket, or shield, which goes to exclude to a considerable extent air from access to the metal in the process of transfer from the rod to the weld.

This gaseous blanket improved the properties of the weld very greatly. It was one of the revolutionary steps in the conduction welding process.

533 At the bottom of the page is shown the clay flux process which I did not know about until I became connected with this case. The welding rod is shown. The clay flux is shown at the left and behind it is shown weld metal and slag.

Here the shielding from gas access is less effective than in the coated electrode process.

Q. You said "gas access." You meant—

A. Air access. Thank you.

Q. Go ahead.

A. Now, if we examine and compare these three processes with the present one, then we see, as I have put down here in comparative notes on the left and right, that in these earlier processes a free gaseous atmosphere exists between rod and plate, a free atmosphere of gas extends between rod and plate, and in this gaseous atmosphere the molecules of air and of steel are ionized, thereby being rendered capable of carrying the electric charges which constitute the current.

Such an electric discharge in a gaseous atmosphere is commonly designated as an arc. Much of the air present, oxygen 20, nitrogen 80, reacts with the superheated
534 finely divided steel and injures its properties.

In the Jones process a pool of fused melt lies between the rod and the plate. Typically absent in this process is any free gaseous atmosphere. Such atmosphere is excluded or displaced by a pool of fused melt which contacts both the rod and the plate, the entire pool is ionized and thereby rendered electrically conductive.

The core of the pool is of low density, being constituted by the fused melt and rod. If the density of this core is low enough to be classed as being in the vapor phase, then conduction through this vapor may be designated as an "arc", since vapor is, strictly speaking, a form of gas.

The arc which appears to be present within the pool of fused melt is, however, formed by vaporous melt itself, with the probably admixture of iron vapor, within the

mantle of liquid fused melt, and which mantle also participates in the conduction.

In the sense and terminology of the Jones patent any so-called arc of the usual type or air-conducted or gas-conducted arc is excluded from the welding zone by the immersion of the rod in the pool of fused melt. It always seems to epitomize this entire process for me to realize
535 that its essential objective and purpose is to melt and transfer liquid metal under protective conditions.

A second difference between the two that enables us to understand better the process in suit is that the generation of additional gas for the welding zone is carried out in the earlier processes. In all of these prior processes a large volume of gas is generated in the welding zone as the rod melts. Gases are generated which help stabilize the arc. In coated rods this was a more or less fortuitous result, the intent of putting the gas-generating materials in the coating having been to shield the weld from the air by a blanket of gas. Shielding by such blanket is, however, incomplete.

In this process, on the contrary, the prevention of gas generation at the welding zone—

By Mr. Wolfe:

Q. You are referring now to the process of the patent in suit?

A. The process of the patent in suit.

In this process the generation of gas at the welding zone is rigorously suppressed. The composition should be
536 substantially anhydrous and free from gases, the patent says, and all reactions which would evolve deleterious amounts of gases during welding should be substantially completed before the medium is used in the welding process.

So that this step, if I may be allowed to say so, operates in the opposite direction for the protection of the weld metal.

Another method of appreciating the difference is that in the older welding processes there is a blinding glare; brilliant and dazzling light is emitted by the open arc, requiring the operator to use a heavily opaque shield. The heat radiated to the operator is nearly unbearable—uncomfortable, to say the least—and showers of molten metal from

the partially enclosed arc render it impractical, with high currents.

538 Mr. Wolfe: At this time, if the Court please, I would like to offer in evidence some of the specimens that have been previously marked for identification.

First I will offer in evidence the specimen previously marked as Plaintiff's Exhibit No. 168; also the weld sample previously marked Plaintiff's Exhibit 169; and the weld samples previously marked respectively Plaintiff's Exhibits 172-A and 172-B.

The Court: Admitted.

(Whereupon said specimen and weld samples marked PLAINTIFF'S EXHIBITS Nos. 168, 169, 172-A and 172-B were admitted in evidence.)

By Mr. Wolfe:

Q. Before we recessed this noon, Dr. Doan, you were explaining this chart, I believe, which has been marked for identification as Plaintiff's Exhibit No. 173, and you had been over this second note in the left column. Will you pick up there, please.

A. The coated electrode process provided for the generation of additional gas for the welding zone, to protect the metal during transfer.

In all of these prior practices a large volume of gas

539 is generated at the welding zone as the rod melts.

Gases are generated which help stabilize the arc. In coated rods this was a more or less fortuitous result, the intent of putting gas generating materials in the coating having been to shield the weld from the air by a blanket of gas.

Shielding by such blanket is, however, quite incomplete.

Whereas, in the present process, the Jones process, the prevention of gas generation at the welding zone is one of the purposes.

In the Jones et al process, generation of gas at the welding zone is rigorously suppressed.

Quoting from page 3, column 1, lines 5 to 11 of the patent:

"The composition should be substantially anhydrous and free from gases, and all reactions which would evolve deleterious amounts of gases during welding should be substantially completed before the medium is used in the welding process."

540 Q. What is meant by anhydrous?

A. Free from water.

Q. You may go ahead, please.

A. In the third place, in the earlier welding processes, brilliant and dazzling light is emitted by the open arc, requiring the operator to use a heavily opaque shield. The heat radiated to the operator is quite uncomfortable, and showers of molten metal from the partially-enclosed arc render it impractical with high currents.

In the Jones process there is an absence of blinding glare. When a normal burden of granular melt is used there is no visible sparking and, indeed, scarcely any external evidence that the weld is being made.

In the fourth place, and last,—and I might pause there to summarize what we have gone over. This Jones process, as we say, provides a means of protecting the molten metal during transfer, that protection being of such completeness that it gives weld metal properties not inferior to those obtained with the coated electrode.

We come now to an additional accomplishment of this process. The maximum usable current is rigidly limited in the prior welding processes. In each of the forms
541 of metal arc-welding available in the prior art there was a rigid, inherent limitation of maximum current that could be employed. Currents in excess of such values sent the metal in a wild and useless spatter. We had a demonstration yesterday of hand arc-welding with an excess current.

For high quality welds a coated electrode was imperative and its current, with for example a quarter-inch diameter electrode, was limited to about 300 amperes. Limitation on current gave a limited depth of penetration for each pass. About one-eighth inch was maximum depth of penetration, per pass, with a coated electrode.

For clay flux maximum penetration was approximately one-half inch.

In the Jones process, in contrast, the usable current has been multiplied many times. In the Jones process current can be increased to 1200 amperes when using a one-quarter inch diameter electrode. That is 1200 amperes contrasted with 300, not an increase of 10 per cent or 25 per cent or 100 per cent, but of several hundred per cent. Penetration is greatly increased, making it possible to weld one inch, two inch or even two and one-half inch
542 plate in a single pass. Greater penetration melts

larger proportions of plate metal and economizes rod. Ratio of plate to rod melted is increased from about 10 to 25 per cent for prior processes, in some instances perhaps 50 per cent, to about 66⅔ to 75 per cent for the Jones process.

If I may recapitulate, what I have tried to say here in contrasting the Jones process with the earlier welding processes—I would summarize it in this way, that protection for the metal during transfer is provided by a pool of molten welding composition, a conductive pool, instead of by gases to shield the arc; that the protection is just as complete, apparently, judging by the properties of
543 the finished weld, as in the earlier welding methods; but that in addition to this protection, a speed of welding hitherto entirely unapproachable, rising from 10 to 20 times that obtainable previously is made possible; and that the troublesome, uncomfortable and sometimes dangerous glare from the open arc is entirely obviated.

Q. You mentioned this morning, Dr. Doan, I think while we were showing some of the pictures, that you had a sample of this slag that would show its transparency or translucency.

A. Yes. I picked up a few, just without thinking.

Q. Are those the specimens you had reference to?

A. Yes. These are the ones.

Mr. Wolfe: I will ask that that be marked for identification as Plaintiff's Exhibit 174.

(Whereupon the said article was marked Plaintiff's Exhibit 174 for identification.)

By Mr. Wolfe:

Q. What were these specimens taken from, Dr. Doan? Will you tell us about that?

A. They were taken from the fused layer of flux
544 that floated on the top of the weld after it was completed, and they happened to chip off during removal of the—

Q. Can you hold one of those up to the lamp there to show its transparency?

A. Yes. An easier way is to lay it down over a piece of printing, and see the printing through it. Some of them are a little bit more suitable than others.

Q. Does it display that same transparency in the liquid stage?

A. It does, and I pointed out the blue light which will show through the top of this pool during welding in the high-speed motion picture this morning.

Q. Now, in the patent in suit, Dr. Doan, what reference or references do you find in the specification of the patent to the electrical phenomenon that is involved in this process, as to its identification?

545 A. On page 4 of the patent, at line 41, it says:

"Several circumstances—"

By Mr. Wolfe:

Q. Just a moment, please, Doctor. Which column is that?

A. I beg your pardon. Column 1.

Q. Yes.

A. (Continuing) —show clearly that our process does not depend on the formation of an arc of the usual type.

Q. Did you have any further points you desired to add there, Doctor?

A. Well, there is another reference just below that, in the same column, beginning with line 54.

That is quite a long one, however.

Q. You are referring now to the paragraph that begins with line 54, are you?

A. Yes.

Q. In that same column?

A. Yes, sir.

Q. Well now, let us take those up one at a time. As a matter of scientific fact, what have you found as to the verity of this statement, that there is no arc of the usual type?

A. It is undoubtedly correct.

546 Q. In connection with that statement, I would also like to call your attention to a portion of the File Wrapper that Mr. Cahill read the other day.

On plaintiff's Exhibit No. 126, which is the second of the series of applications, it appears that the words "of the usual type" were added to that sentence in an amendment dated November 2, 1934, which is Official Paper No. 3 in that file, and in that amendment there was this statement by the attorneys, which Mr. Cahill read:

"Applicants' specification has been slightly amended, where it discusses the theory of their process, and compares this process with prior art processes.

"It is immaterial to the patentability of the invention whether applicants are able to give the correct theory or not, but it is their purpose to give the Examiner the fullest information in their possession, on this matter.

"It is difficult, if not impossible, to define an arc precisely, and applicants have contemplated the possibility that a definition may be framed in such terms as to embrace the phenomenon which occurs in their process."

Now before going further into that paragraph, Dr.
547 Doan, I would like to put this question to you:

In your studies of the literature in this field, have you found a certainty of definition of "arc"?

A. No, I have not.

Q. Can you refer us to some authorities, by way of example, of definitions which are given in authoritative works in this field?

A. Yes, I can. The Professor of Physics at the University of California, Leonard B. Loeb, wrote a textbook called "Fundamental Processes of Electrical Discharge in Gases", which was published by Wiley and Company in 1939.

The first six hundred pages are devoted to discharges in general and especially to glow discharge, and on page 605 we come to Part B of the book, "The arc discharge", from which I quote:

"Although the electrical arc was discovered in the form of the carbon arc by Davy in 1808 to 1810, shortly after the discovery of the voltaic pile, its mechanism is less understood quantitatively than the glow discharge."

Continuing the quotation:

548 "As will later be seen, if one is willing to redefine the concept of temperature to apply to the microscale of occurrences which take place at the cathode under some conditions, it is probable that one may be able to define an arc as a discharge whose cathode mechanism depends largely on thermionic emission. Until the acceptance of this idea becomes more universal we will define the arc in terms of its low cathode fall and large current density."

Q. Now, in connection with that statement of his there, as to defining the arc in terms of its low cathode fall and large current density, in the case of the discharge in the present welding process, have you been able to measure the cathode fall?

A. No, it has not been possible to do so.

Q. So it isn't possible to fit that kind of a definition to this phenomenon?

A. Not with certainty.

Q. What other examples can you cite for us?

A. A man named Winifred, writing a book in England in 1940 called "Electrical Contacts", says, on page 209,—

Mr. Byron: May I inquire at this time, is this specific to electric arc-welding, or just plain electric dis-
549 charge? Because if it is just the latter and it is not arc-welding with a bare electrode, it is totally irrelevant and immaterial.

The Witness: It is on the question of fundamental processes of the electric arc.

My Byron: That hasn't been made clear.

By Mr. Wolfe:

Q. You may proceed, Dr. Doan.

A. Winifred says, on page 209:

"There is a wide variety of types of arc discharge, representing different arc phenomena, but all these are characterized by the intensiveness of the carrier producing process, giving rise to considerably higher current densities than the previously considered forms of discharge."

Q. What do you find in the German literature?

The Court: Before you proceed, I would like to have the witness give me some idea of what is meant by large current density and low cathode fall.

By Mr. Wolfe:

Q. Will you do that, Dr. Doan, please.

A. Yes, sir. If the arc is established between this pencil and this plate, the current density would be
550 the number of amperes per unit of charge flowing per unit area. The current density would be the number of amperes per unit, cross section.

We might compare it with the number of automobiles in a stream of traffic, per hundred feet width of street, or with the amount of water flowing through a pipe, expressed in terms of rate of flow of the water in cross section of the pipe, per square inches.

The cathode fall is the change in voltage between the terminal itself and a space a very short distance away from that terminal, that distance being of the order of the mean free path of one electron before it collides with others.

551 In other words, the cathode fall is the voltage drop at the electrode surface. I should perhaps put it this way, that if an arc was struck between these two electrodes there would be a voltage drop from this point to this point (Indicating).

In these instances that we have been discussing there has been in the neighborhood of 40 volts. That 40 volts is not lost, however, uniformly from this point to this point (Indicating). Most of it is lost at this contact and at this contact (indicating); perhaps 90 per cent of the voltage is absorbed at those two inter-faces and the remaining 10 per cent is absorbed in the stream itself.

The cathode fall, then, is the drop in voltage at the cathode surface, and the anode fall is the drop at the anode surface.

Q. One of your electrodes is called the anode and the other electrode is called the cathode?

A. Yes, the anode being usually the positive and the cathode the negative.

Q. With respect to the electrodes mentioned, you had in mind what, any pair of wires or something like that?

A. Well, yes. In the case of welding it is the wire
552 or rod in one case, and the plates; the wire or rod is one electrode and the plates form the other electrode, the arc being established between them.

Q. Now, you had, I think, some reference to the German literature on the subject too, Dr. Doan, did you not?

A. Incidentally, I read the wrong abstract from Winifred. It was not quite as illuminating. I will read the right one, if I may.

Q. Do you have another one?

A. Yes. He says on page 200 as follows:

"Studies carried out with the aid of modern research methods and on the basis of modern physical theories have yielded a large amount of knowledge concerning the nature of the arc and its behavior under given conditions. It must not be inferred, however, that the theoretical aspect has reached finality. The subject is still in an evanescent state, perhaps largely on account of the difficulty of correlating and unifying the various branches."

Then Seeliger in a book called "Handbook of Experimental Physics," published in Leipzig in 1929,
553 classifies the arc into three main types, which may aid us with respect to the participation of the electrode vapor in the discharge.

That is to say, the discharge is one of electricity through a vapor of gas between these two electrodes, and that vapor determines to a considerable extent the nature of the discharge. The vapor may come from the air, as it does in a free gaseous arc. It may come from the electrodes, as it does in other instances, the mercury vapor arc, for example. Or it may be a mixture of the two.

Seeliger classifies them into three groups.

"First, the discharge space filled exclusively with electrode vapor. As a typical example, mention can be made of the metal arcs in tubes which are completely evacuated before the arc is struck, such as the mercury vapor lamps, mercury arc rectifiers, and so forth.

Second, the discharge space only partly filled with electrode vapor. To this class belong all open burning metal arcs, and in a broader sense also the ordinary carbon arc.

Third, the discharge space free from electrode vapor; as an example, the tungsten arc lamp with practically
554 non-vaporizing electrodes in an inert gas filling."

Q. To which, if any, of those three classifications would these prior art welding arrangements that you have on the left side of your chart, 173, belong?

A. Well, they would belong to the class in which the discharge space is only partly filled with electrode vapor, and in which the air, the gaseous environment participates extensively.

Q. To which of those three classes, if any, would the phenomenon of the process of the patent in suit belong?

A. It does not belong to any of them.

Q. *How broad a definition* of an arc are we going to have to accept if we want to call this thing in the process of the patent in suit an arc?

A. Well, if you include any discharge of electricity through gas, then this would fall in that category.

Q. Now, in further reference to this paragraph I was reading here from the file wrapper, it continues from where I left off reading:

"There can be no question, however, that there is no such arc involved in their process as occurs in every
555 prior art process including that of Robinoff, et al."

What do you have to say, Dr. Doan, as to the accuracy of that statement?

A. I believe that is a correct statement.

Q. Now, to give us a little more detail about the phenomenon or arc that is involved, unusual type, or what-

ever it be, of the process of the patent in suit here, what factual material can you give us as to distinctions of it over open arc processes of the prior art?

A. There are quite a number of them. As I mentioned, the arc is influenced by the atmosphere in which it forms, in which the discharge occurs. We have seen on that previous chart that some changes in the arc atmosphere, the bare arc atmosphere, occur when the coating supplies gases to it; for example, some increased stability.

556 We know also that if hydrogen is substituted as the gas between the electrodes, much higher voltages are required to transmit the same amount of current.

Q. That is in what sort of a set up, Doctor?

A. For instance, in the bare arc process, or in a carbon arc, just as well.

On the other hand, we learned a number of years ago, from some experiments, that if you put argon, highly purified argon, which is an inert gas, which does not participate chemically, between the electrodes, you cannot form a stable arc; it goes out.

So that the gas that is developed between the electrodes has a very important influence on the type of the discharge.

In this present process, the medium between the electrodes is vaporized melt, and no doubt some vaporized steel. That is, the arc is constituted in the vapor of the pool itself, and although we do not know, by any means, all of the differences, or all of the features and peculiarities of this pool, I can say that there may well be a great many.

I can speculate about this, but I certainly do not desire to do so.

557 Q. What experiments have you conducted in reference to the susceptibility of the present process to changes in atmospheric pressure as compared to the ordinary open arc processes of the prior art?

A. We have tried making welds in a vacuum, in a large tank from which the air was pumped, so that the pressure came down to less than one millimeter; as a matter of fact, to about .2 millimeters.

I have some pictures here of that tank.

Mr. Wolfe: I will ask that this set of photographs—there are three of them—be marked at this time for identification as Plaintiff's Exhibits 175-A, 175-B and 175-C respectively.

By Mr. Wolfe:

Q. Now, Dr. Doan, will you please point out the set up that is shown in these photographs, to the Court.

558 A. Yes, sir.

Well, two of them show exterior views of the tank, which was evacuated, showing the control instruments—

The vacuum gauge is shown on this one, marked Z-11413, which is at my right. It is a little bit indistinct, perhaps.

The welding controls are shown at the extreme left in the same view.

In Z-11412 the manhole is shown, where the welding equipment was inserted, and where the precedure was watched during the welding.

Q. What sort of welding equipment did you have in that tank, Doctor?

559 A. We used the standard Unionmelt equipment.

Q. An automatic welding machine, was it?

A. Yes.

Q. And was that controllable from the outside of the tank?

A. Yes, remote control.

Q. Well now, will you just tell us what experiments you performed with that arrangement for putting the welding machine in a vacuum.

A. Well, we made one here on October the 16th, with half-inch plate, 600 to 700 amperes, 30 to 40 volts—it turned out to be about 35 volts, as I recorded it; 3/16ths inch rod; 9 to 11 inches per minute.

We evacuated the tank until there was a pressure of only 250 microns, about a quarter of one millimeter, the atmospheric pressure being 760 millimeters.

Q. Of mercury?

A. Yes, sir.

Q. Yes?

A. The weld which was produced was coherent, and rather peculiar in that it was narrow and high, rather than flat and wide, as the ordinary welds.

I think I have one of those here.

Q. You have a specimen of that here?

560 A. Yes, sir. That is X-220.

Mr. Wolfe: I will ask that this specimen be marked as Plaintiff's Exhibit No. 176 for identification.

(Whereupon said specimen was marked Plaintiff's Exhibit No. 176 for identification.)

By Mr. Wolfe:

Q. Is this the specimen to which you have just referred, Dr. Doan?

A. Yes, it is.

Q. Now, when that specimen was made in the vacuum tank, as you have described, what welding composition or flux if any were you using?

A. Unionmelt 20.

561 Q. Now, did you make any comparative tests under similar conditions of vacuum?

A. Yes, I did. I made one later, that is, on the 25th of November, under the same conditions except that this time we got down to 200 microns, instead of 250, in which we used in line the clay flux, the Unionmelt 20 and the Lincoln 660 flux.

Q. And what results did you get from that?

A. I have recorded the results here, that during the welding the Unionmelt gave a purplish glow at intervals when a bubble breaks; that the Lincoln 660 was completely covered, and that the clay flux gave a continuous open arc.

Q. What was the character of the welds produced with those three materials?

A. The Unionmelt weld again was high and narrow but continuous, like this specimen; the Lincoln was a high narrow weld and continuous; and the clay flux was spotty and bumpy and discontinuous. I would not call it a weld.

Q. Did you make any attempts to use any other open arc in the vacuums, besides the clay flux?

A. We did some welding with coated electrodes.

Q. And what was the result of those attempts?

562 A. They gave just a spatter of little globules in the neighborhood of the weld, not a weld at all.

Q. So to summarize it, if I understand you correctly, in the open arc processes with either the—

Mr. Byron: I think it would be well to let the witness summarize it.

By Mr. Wolfe:

Q. All right, go ahead, Doctor, and summarize.

A. Well, the purpose was to see whether there were other differences in this process than were found under ordinary conditions; and the results showed very clearly that the arc in this process behaved quite differently at reduced pressure from either the coated rod process or the clay flux process.

Q. And you found that same distinction for both Unionmelt and Lincoln, did you?

A. Yes, they behaved the same.

Q. Now, as to another matter of summary, Dr. Doan. You have mentioned at various times different advantages and superiorities of the process of the patent in suit. I wish you would summarize for us the principal advantages of the process of the patent, particularly from the industrial user's point of view.

A. The industrial user isn't interested in the mech-
563 anism, but the pool does provide a degree of protection which is not surpassed by any of these earlier processes.

The thing that amazes me and must amaze the producer is the speed with which this process can be operated. When you realize that in that cubic inch or so of a pool of welding composition a hundred horsepower is being transmitted, it is perfectly amazing that the pool can remain and transmit that amount of current.

When a speed ten times and frequently twenty times that obtainable with the earlier processes is achieved, the industrial user, of course, doesn't ~~have to~~ have the advantage pointed out to him.

When the operator is relieved from the glare and the danger of wearing a hood—especially if he is working on a high place and, with the hood around him, may fall and be injured—it is not necessary to point out to him the improved operating conditions which are obtainable.

When a weld is made in thick plates with a single pass, and that large reservoir of molten metal present, the cooling rate is much reduced. With this reservoir of heat con-
stantly present, the flow of heat takes place gradually
564 from the joint, and a much slower cooling rate is obtained. That is important because a high cooling rate is equivalent, in many respects, to plunging a hot piece of metal into a tub of water.

With many steels this quench will harden and embrittle the area adjacent to the weld in an undesirable way, whereas with this large reservoir the cooling rate is very much slower and the hardening is very much less.

In addition, in welding such thick sections with a single pass as we have seen here, the entire cross-section of the
plate is heated at one time, and therefore as the weld
565 cools contraction is more uniform and there is less tendency to warp and twist than when single-end welds

are laid down as by the earlier processes. The heating is uniform and less distortion of the final structure results.

Those appear to me to be some of the principal advantages to the industrial user of this invention.

Q. You have spoken of the use of this process of the patent in welding thick plates, and so forth. What can your tell us of its use on thin plate welding?

A. One-eighth inch thick steel sheets can be welded as I recall, at speed of 180 feet per hour, which is a very high speed.

Q. Have you made any comparative tests of the abilities of the process of the patent in suit in welding thin plates at high speed, as compared with clay flux?

A. Would you repeat that question, please?

Mr. Wolfe: Perhaps it was not very clear.

By Mr. Wolfe:

Q. I want you to tell us of any tests you have made in comparing the capabilities of the clay flux process and the process of the patent in suit in welding thin plate at high speed.

566 A. I have had such welds made, and the clay flux, as I recall it, gave merely a discontinuous spatter of particles, and a very rough surface.

Q. And at that same speed, what results did you get with the process of the patent in suit?

A. We got a smooth, coherent, highly satisfactory surface, just as we did with all of these others.

Mr. Wolfe: There are some items here, your Honor, that we have previously had marked for identification, that I would like to offer in evidence at this time.

First, I offer in evidence the chart marked for identification as Plaintiff's Exhibit No. 173; next, the set of photographs which have been marked as Plaintiff's Exhibits 175-A, 175-B and 175-C respectively; the specimen which has been marked as Plaintiff's Exhibit No. 174; and the other specimen over there, which I believe has been marked as Plaintiff's Exhibit 176.

The Court: Is there any objection?

Mr. Byron: No objection.

The Court: Admitted.

567 (And thereupon PLAINTIFF'S EXHIBITS 173, 175-A, 175-B, 175-C, 174 and 176 were admitted in evidence.)

By Mr. Wolfe:

Q. Now, Dr. Doan, I would like to turn to still another aspect of the case with you at this time.

Do you have any familiarity with the so-called Lincolnweld process of welding that has been accused here as an infringement?

A. Yes, sir, I have made a large number of experiments with it.

Q. What sort of experiments?

A. Well, in almost all of the tests which I have made with the Unionmelt welding conditions, I duplicated them with the Lincoln Flux 660.

Q. Have you seen it demonstrated publicly by the Lincoln people themselves?

A. I saw it demonstrated at the Annual Welding Society Convention in Atlantic City this fall, yes, sir.

Q. Now, will you state for us, if you please, Dr. Doan, the general outlines of the operation of the Lincolnweld process?

A. The welding composition is laid along the joint
568 to be welded; the electrode is immersed in a pool of fused welding composition. The metal is transferred from the electrode through this pool to the joint. The current flows from the electrode through the pool to the joint.

Q. In what respects does that process contrast with or differ from the process which you have described here, in this patent?

A. The process is identical, in all respects.

Q. What investigations have you made of the particular point of contact of the electrode with the fused pool which you mentioned, in the Lincolnweld process?

A. In every instance where we checked the contact of the electrode with the pool in the Unionmelt process, we checked it likewise with the Lincoln flux.

Q. You mentioned some specific tests this morning that you had used in that respect.

Are there any others that you used, in connection with the Lincoln materials, that are significant?

A. Why, I do not think that I mentioned all of them this morning, that we did, by any manner of means.

There was another one in which we used a hollow electrode, on this postulate, that if the electrode were immersed in a pool, drawing by suction on a hollow electrode
569 should draw some of the molten welding composition up into the electrode.

We did try that with both materials, and we found that some of the molten composition was drawn up into the electrode.

570 Q. Where did you find it in the electrode?

A. In this annular cavity, principally near the top.

Q. And what other investigations along that line did you make; as, for example, did you use any prods or probes?

A. Oh, yes; I forgot those, too. If the rod is immersed in a pool, then while the process is proceeding if one should insert a thin wire down the side of the electrode but not getting under the tip of the electrode, that probe or wire should make contact with the flux pool.

So we tried that, advancing it down the side and then withdrawing it, and when we withdrew it we would draw out a thread or streamer of red-hot viscous molten flux. Then we would try it in front of the electrode and withdraw it, and try it in back of the electrode and withdraw it, and we found the electrode was in fact immersed in a pool of molten flux.

We tried that same experiment using the Lincoln 660 flux, and we got the same results.

Q. You have a specimen weld here, I believe, made with the Lincoln process, is that right?

A. Yes, sir.

571 Mr. Stewart: May I ask, was this made by Dr. Doan with the Lincoln process?

The Witness: Yes, sir, it was.

Mr. Wolfe: I ask that this specimen be marked for identification Plaintiff's Exhibit 177.

(Whereupon the said article was marked Plaintiff's Exhibit 177 for identification.)

By Mr. Wolfe:

Q. Will you state the conditions under which that weld was made, Mr. Doan?

A. It was made with 850 amperes, 28 volts, 16 inches per minute, quarter inch rod, Lincolnweld 660 flux, half inch plate.

Q. Was it made with more than one pass, or—

A. That is a single pass.

Q. Will you take specimen Exhibit 166. That, I believe you told us, was one you had made with the process of the patent in suit. How does that compare with this last specimen?

A. It was made with 850 amperes, 28 volts, 16 inches per minute, quarter inch rod, just as the previous one.

572 Q. Was there any difference in the conditions?

A. No difference.

Q. How do the structures of the welds compare?

A. Well, they are exactly the same type of structure.

Q. You have X-rays of the completed welds which we might examine?

A. Yes, I have.

Mr. Wolfe: May me put this light box for viewing the X-rays on the bench, your Honor?

The Court: You might place it over there.

By Mr. Wolfe:

Q. Are these X-rays to which you refer, Dr. Doan?

A. Yes, they are.

Mr. Wolfe: I will ask that they be marked for identification as Plaintiff's Exhibits 178 and 179 respectively.

(Whereupon the X-rays referred to were marked Plaintiff's Exhibits 178 and 179, respectively, for identification.)

By Mr. Wolfe:

Q. Dr. Doan, will you show the Court these X-ray
573 negatives on the light box and point out which they are?

A. This is the Unionmelt weld. With respect to this X-ray, it can be understood most easily by remembering that when a dentist X-rays your tooth or you have a bone broken in your arm, the rays shine through the arm onto a negative film, and where they shine through the most intensely—that is, in the low density parts like the flesh—the film will be darkened most, and where there is a more dense region like a bone, there the film is darkened less.

So this is a region which is a little bit thicker (indicating). That is the weld, the shadow of the weld. It is a little bit thicker, you see, a little bit reinforced over the neighboring plate, and here is the weld (indicating) made by the same process using the Lincoln flux.

I do not think they show anything particular, except they are both homogeneous, sound welds.

Q. Is there any evidence of porosity in either of them?

A. Neither of them. This particular little marking here (indicating) we have found is the run-through on the underside, slightly reinforced also.

574 Q. That is, that sort of smeary appearance?
A. Pardon me?
Q. That sort of smeary appearance.
A. Yes; sort of serrated.
Q. If there were porosity there, how would it show in such an X-ray?
A. Well, porous regions would be regions of low density through which the rays would pass more intensely, and therefore they would appear as dark spots.
Q. Sort of dots or blotches?
A. Yes.
Mr. Wolfe: I offer those two X-rays in evidence, as well as the specimen, 177, which was one of the two to which they pertain.
The Court: Is there any objection?
Mr. Byron: No objection.
The Court: They may be admitted.
(Whereupon the said articles marked PLAINTIFF'S EXHIBITS 177, 178 and 179 respectively, were received in evidence.)
575 Q. In your investigations of this Lincoln material, Dr. Doan, did you make high-speed movies of it in reference to the matter of contact?
A. Yes, I believe I did include those, yes, sir; as a matter of fact, I am sure I did.
Q. Will you please examine the reel that I now hand you, and state for us the conditions under which the pictures were taken?
A. This was taken with Lincoln 660 flux, with a tapered burden, beginning, as I described this morning, with a very thin layer, and increasing it gradually along the length of the weld; with a ¾-inch thick plate; with current of 1200 amperes, and 40 volts; a speed of 12½ inches per minute; and ¼-inch rod.
Now a part of this reel was taken at the rate of 350 exposures per second, which slows the action down to approximately 1 20th of the normal speed.
A part of it was taken at 64 frames per second, under the same welding conditions, which slows it down about ⅓ normal speed, instead of 1 20th.
Q. Now at what point in the travel of the rod along this tapered burden of flux which you have described, were these pictures taken?

576 They were taken at what we call the close-in, where the rod becomes for the first time immersed in the pool of molten welding composition.

It is an attempt to get it exactly at that time.

Q. It would begin, then, in the picture prior to that time, and go through the transition stage: is that correct?

A. Yes.

Q. That is what you tried to take?

A. Yes, sir.

Q. Where were these pictures taken?

A. At Niagara Falls.

Q. Do you know when—or do you remember when?

A. I believe in October of this year; that is, it was either October or November of this year.

Q. 1946, do you mean?

A. Or rather, I mean to say, 1946, yes, sir. I beg your pardon.

Q. You were personally present, were you?

A. Yes, I was.

Q. You have seen this reel projected?

A. Yes, I have.

Q. What do you have to say as to whether or not it faithfully shows the operation that was photographed?

577 A. It faithfully shows what?

Q. The operation that was photographed.

A. Well, it is the best we can do with motion pictures, I think. We had the best man in the country do it; but it is nothing like watching it, for this reason: The light comes entirely from the open arc at the beginnning, and you can photograph that very nicely; but at the time the closing is completed, then the light is shut out and you don't get very good illumination.

Mr. Wolfe: I offer this reel in evidence as Plaintiff's Exhibit 180.

The Court: Any objection?

Mr. Stewart: No objection.

The Court: It may be admitted.

(Whereupon said reel, PLAINTIFF'S EXHIBIT 180 was admitted in evidence.)

Mr. Byron: Are we going to see it?

Mr. Wolfe: Yes, we will have it projected now.

In this instance again, I believe there are some single frames provided at the beginning of the reel, and if you will step down, Dr. Doan, and point out on the screen

the items that appear, it will help us in viewing the
578 rest of the motion picture.

(The witness leaves the witness chair, and the single frames are projected on the screen.)

By Mr. Wolfe:

Q. All right, Dr. Doan, will you point out what happens here in this picture.

A. This (indicating) is the electrode being fed down into the molten pool. This is the pool here, and here is a white hot portion of the pool.

The blue glow back here, I am not sure whether it is transmitted through the translucent pool or whether it is still a temporary flare-out of the closing in process being not yet completed at this stage.

Here the closing in has advanced further. The molten flux can be seen plainly in contact with the electrode, and it seals it in on all sides.

Here is the electrode in this instance, then again the pool of molten welding composition.

Mr. Byron: What is the blue?

The Witness: That is either blue light transmitted through the translucent flux, or a blue flame which has broken through here in this not thick enough pool.

579 Mr. Byron: You are not sure what it is?

The Witness: In this instance I would not say definitely.

Mr. Byron: Well, you don't know?

The Witness: Because I don't know.

Here again you see the pool, and this electrode, with the rod immersed in the pool; and here—

Mr. Byron: Pointing at the blue?

The Witness: I must not guess, but I think that is a break through at that point, that white area right there.

Mr. Byron: And again you don't know?

Mr. Cahill: May the witness testify, please, your Honor, without this constant interruption?

Mr. Byron: Well, we want to know about the picture.

The Court: Well, I will permit cross-examination of the witness with each picture, otherwise we will have to have the reel run over.

Mr. Cahill: Counsel has interrupted the witness repeatedly. It amounts to heckling the witness.

580 Mr. Byron: Not that at all.

Mr. Cahill: I submit the witness should be permitted to complete a statement.

The Court: You may announce, Doctor, after each explanation, that you are through with that particular picture, and the Defendants' counsel may make whatever cross-examination they wish with reference to the testimony on that picture.

Mr. Byron: I might say, in view of the fact that Colonel Stewart is going to cross-examine this witness, that he should ask the questions that are asked.

The Court: Proceed, Doctor.

The Witness: This is definitely a break through here in the insufficiently deep pool, because you can see particles of the granulated flux being projected upward.

Here, on the contrary, the pool is continuous, and the electrode is immersed in it.

Mr. Stewart: Dr. Doan, may I ask one question: That blue is the characteristic color of the electric arc, is it not, that blue in the display?

The Witness: I would say it is.

581 Mr. Stewart: That is all.

Mr. Wolfe: That is the last frame. Now we will have the movies.

582 (The projection of a reel of moving pictures was commenced.)

Mr. Stewart: Dr. Doan, what are those deleterious gases coming off of the welding operation?

The Witness: I do not know whether they are deleterious and I do not know whether they are gases.

Mr. Stewart: What is that apparent smoke?

The Witness: I do not know.

Mr. Stewart: Has the pool closed in yet, Dr. Doan?

The Witness: No. It is wide open, and that is why there is so much smoke coming out.

Mr. Stewart: How much flux is on there, do you know? What is the depth of the layer?

The Witness: It tapers from zero at the beginning up to a maximum at the opposite end.

We are trying to get it here, just as it closes in. At this particular point my recollection would be that—I suppose I should not try to remember.

Mr. Stewart: That was not zero, at that point; there is some flux on there?

583 The Witness: Oh, yes. It is just on the point of closing in.

Mr. Stewart: At least a half an inch?

The Witness: In the neighborhood of a half an inch. A little bit less, probably.

Mr. Stewart: Still a half an inch?

The Witness: You must remember that this entire reel covers only ten seconds.

Mr. Stewart: I see. Now, at this point, these particles that are being thrown out—are those molten flux?

The Witness: Or steel. There it is beginning to close in now. There will be recurrent outbursts, however, because it does not close in quite uniformly. You see, as it closes in the light diminishes.

Mr. Stewart: And continues to be blue, does it not?

The Witness: Yes. Now, this is the slower view; instead of one-twentieth it is one-fourth.

Mr. Stewart: You mean it is faster, do you not, Doctor?

The Court: I do not hear you, Mr. Stewart.

Mr. Stewart: It is faster, is it not, rather than 584 slower, the movement?

The Witness: No. It is slower—I mean, it is slowed down less, yes. It is more nearly normal. That is right.

Mr. Stewart: That is one-fourth normal, is that it?

The Witness: Yes. I believe it is.

Mr. Stewart: Then those flashes would be four times as fast as they appear?

The Witness: That is right. It is closing in now. There is an occasional outburst, and you see that quiet flame.

Mr. Stewart: Which quiet flame, Doctor?

The Witness: This reddish one. There is a bursting open here as you have seen frequently, because of too shallow a burden.

Mr. Stewart: Doctor, that is just not quite a completely submerged arc, is it not?

The Witness: I do not believe we had better enter into labels.

The Court: I did not hear you.

The Witness: I do not like to label the thing.

Mr. Stewart: In normal welding terminology is 585 that not the case?

(No response.)

Mr. Stewart: May I ask for an answer, your Honor?

The Witness: I do not know what you mean by "normal terminology."

The Court: Shut the machine off.

(The projection of the moving picture reel was thereupon stopped.)

The Court: What was the question?

(The record was read.)

The Witness: I think it would be misleading to give it that title. I think it would disregard the important factors in the situation. I do not know who gives it that title.

Mr. Stewart: That is your answer?

The Witness: Yes, sir.

The Court: You may proceed with the demonstration. Are there any other questions?

586 Mr. Wolfe: I have no further questions on that.

(The projection of the moving picture reel was thereupon resumed.)

The Witness: It is just about closed in now, as you perhaps can see.

There is the pool shown very plainly. Now it bursts.

Mr. Stewart: Has it closed in as yet, Doctor?

The Witness: Well, at one instant it has, and at the next, it breaks out.

Mr. Stewart: But every break-out has the characteristic blue color of an electric arc, has it not?

The Witness: It has a characteristic blue color, yes, sir.

Mr. Stewart: At this time, Doctor, can you say whether the weld is a good weld, that is being made in that place?

The Witness: This is the transition stage, and you must remember that only a few seconds was involved in this transition here.

Mr. Stewart: But at the time those few seconds were being taken, or running, do you know whether or not

587 the weld was a good weld, or can you say?

The Witness: Well, that was right on the edge. I would say that when those fumes and dense clouds of smoke are coming out, it would not be a good weld.

Mr. Stewart: But at the end, it was; is that correct?

The Witness: Is that so?

Mr. Stewart: I say, at the end it was a good weld, was it?

The Witness: I did not see that smoke cloud disappear even at the end, in this instance.

Mr. Stewart: But there were the same blue flashes, were there not?

The Witness: There were frequent blue flashes, yes, sir.

Mr. Stewart: And what was the matter that the weld was not good?

The Witness: How?

Mr. Stewart: What was the matter, that the weld was not good at the other times there?

The Witness: Oh, it was porous.

588 Mr. Stewart: How deeply; only on the surface, or down into the plates?

The Witness: Well, like this one here.

Mr. Wolfe: Pointing to exhibit what, Doctor? What is that exhibit number?

The Witness: 169.

Mr. Stewart: Is what you are referring to now, a specimen from this particular operation, or another one?

The Witness: Well, now, just a moment, please. I will have to see, to answer that question. I do not think this is from the same one, no, sir.

Mr. Stewart: Did you preserve the weld, the complete weld, that was made when that picture was taken, Doctor? Do your notes show that?

The Witness: I do not believe so.

Mr. Stewart: Did you preserve the plate?

Mr. Wolfe: You may check that later, if your notes are not complete there at the moment, Doctor.

Mr. Stewart: If you do have it, we would like to see it; that is all.

589 I have no other questions at this time.

Mr. Wolfe: Shall we go ahead with the picture, then?

The Court: Yes.

By Mr. Wolfe:

Q. Before we do that, however, would you point out for us, Doctor, here on this specimen to which you have referred, No. 169, about the distance that the electrode goes along that, during the time that we saw it in the movie?

Mr. Stewart: This was the Unionmelt flux that was used in that, was it not?

By Mr. Wolfe:

Q. What was used on this, Mr. Doan, No. 169?

A. That is Lincolnweld 660.

Mr. Stewart: That was Lincolnweld?

The Witness: Yes.

Mr. Stewart: All right.

By Mr. Wolfe:

Q. How far along does the electrode travel on the length of the plate during all of this time that the movie is being taken, Doctor?

A. As I recall it, about three-quarters of an inch.

Q. And in what area here, if you will point that out
590 to the Court?

A. Well, right in this region (indicating), the transition from the thin burden of flux up to sufficient to immerse the electrode.

Q. A travel of about three-quarters of an inch?

A. Yes.

Q. During all of this time that we see it?

A. Yes, sir. It is difficult to get it right at transition, because a movie camera shoots, and then maybe it will open up again, and get nothing.

Mr. Wolfe: All right. Now, will you go ahead with the rest of the film, please.

(The projection of the film was thereupon resumed.)

The Witness: You can see what sort of an explosive force comes out from around that electrode. I do not know how the pool can contain that pressure, but when the burden is a little deeper, it does contain it entirely.

Mr. Stewart: That is the force of the arc, is it not, Doctor?

The Witness: Well, that is a part of it, yes, sir, but probably only a part.

That is about the transition, there, and then it blows out again. You will notice, when it does blow out, the
591 volume of smoke that is emitted.

Of course, that would be an unsatisfactory welding condition.

The Court: I cannot hear you, Doctor.

The Witness: I say, that would be an unsatisfactory welding condition.

Mr. Stewart: How deep is the flux now, Doctor, if you know?

The Witness: How deep?

Mr. Stewart: Yes.

The Witness: Well, I think—I would estimate, between three-eighths of an inch and one-half an inch.

Mr. Stewart: Could it be more?

The Witness: I would prefer not to be asked to guess about it, really.

Mr. Stewart: Now, there is just one further question, Doctor.

The blue flashes still were visible to the very end of that picture, were they not?

The Witness: Intermittently.

(Thereupon the running of the film was concluded.)

592 By Mr. Wolfe:

Q. Now, Dr. Doan, have you had some further motion pictures made, showing the Lincolnweld process at normal speed, and under standard operating conditions, as published for that process?

A. Yes.

Q. Where were those films made?

A. At the laboratory out here at Hammond.

Q. In the demonstration room—

A. Yes.

Q. —where we were the other day?

A. In the demonstration room, yes, sir, with the same equipment that we used.

Q. Do you recall the date when those were made?

A. December the 12th, 1946.

Q. Who else was present besides yourself at that 593 time, if anybody?

A. Well, Mr. Fishleigh was there, and Mr. Cornwell, and yourself; and also Mr. Roberts, who did the welding.

Q. Can you tell us what welding equipment was used?

A. I believe it was the same that we used yesterday—well, no, we used the Lincoln tractor. I have that noted here. That is correct.

594 Q. And what welding rod and welding flux was used?

A. There were three such welds made, one on half-inch plate, one on three-quarter inch plate, and one on one-inch plate.

Q. What flux was used?

A. Lincoln 660 on all three.

Q. And what welding rod?

A. I haven't recorded it.

Q. Did anyone take a sample of it at the time, do you remember?

A. Yes, Mr. Fishleigh did, and of the flux.

Q. What were the welding conditions for these three sizes of plates that you have mentioned?

A. For the half-inch plate, the first side was 625 amperes, 34 volts and 18 inches per minute. For the second side, 850 amperes, 34 volts, 18 inches per minute.

In general all of them were approximately those recommended in the Lincoln catalogue.

Q. What were the conditions for the three-quarter inch plate?

A. The first side, 750 amperes, 35 volts. The second side, 925 amperes, 35 volts.

Q. And for the one-inch plate?

A. And for the one-inch plate, the first side, 800 595 amperes, 35 volts. The second side, 1050 amperes, 37 volts, and a speed of approximately 11 inches per minute.

Q. You speak of first and second sides. How were these welds made?

A. Well, they were welded on one side about half way through, and then turned over and welded through on the second side.

Q. What bevelling, if any, was used on the several plate sizes that you have mentioned?

A. I didn't record the bevelling.

Q. Have you seen the reels of motion pictures projected that were taken at that time, of these welds?

A. I don't believe I have.

Q. I don't know whether I asked you—I thought I had asked you before—were you there at the time they were made?

A. Oh, yes, I was there.

Q. And would you be able to tell, on seeing them projected, whether or not they accurately depict the conditions which you inspected at the time?

A. Yes.

596 Mr. Wolfe: No; I was going to make the offer. I offer these reels in evidence as Plaintiff's Exhibits 181-A and 181-B.

Mr. Stewart: If the Court please, I object to the offer. In the first place, they are an ex parte demonstration of what is claimed to be the use of the Lincolnweld process. There is no evidence or statement here as to the depth of the layer of flux.

Flux can be put on so deep that it will not demonstrate how it is commercially used or how it can be used.

I object to it on those two grounds. It is designed as giving the impression of nothing happening under that flux.

Until we know what the depth of the flux is and the
597 manner of putting it on we can't tell what it is.

Mr. Wolfe: As far as it being ex parte, that goes only to the weight and not to admissibility.

By Mr. Wolfe:

Q. As to the other matter, how was the flux put on in this case, Dr. Doan?

A. It was fed through the feeding device on the Lincoln tractor.

Q. Was there any special adjustment or change made in that feeding device?

A. There was not.

Q. And did you or Mr. Fishleigh measure the depth of the flux layer at the time?

A. We did.

Q. What is the approximate depth?

A. I think that is in some other notes that I haven't here. The depth was that provided by the Lincoln feed mechanism.

Mr. Stewart: May the record show the witness indicated close to two inches between his fingers.

Mr. Wolfe: Let the witness state what his best recollection is.

598 The Witness: I should say about an inch and a half; it might have been an inch and three-quarters.

Mr. Wolfe: I will renew the offer of the ...ms.

Mr. Stewart: We renew the objection.

Mr. Byron: We know how variable these conditions can be. Your Honor saw yesterday how variable they are, and how much advantage was taken by the plaintiff with respect to their particular flux, and the disadvantage with respect to the clay flux. We had to call the Court's attention to the fact that, in addition to Plaintiff's having a deeper layer of flux of their own type, they kept pouring it in as the weld-

ing proceeded, and there was that same level, the ordinary level of the clay flux. Just a plain advantage being taken of its rights before the Court.

How are we going to know? Why should we take their word about an ex parte test when we weren't there at all. They are trying to prove infringement by a thing of that kind.

Mr. Wolfe: We don't go into—

Mr. Byron: Just a minute. Under Court Order, we made some demonstrations on May 21, 1946, at the
599 Graver plant. These gentlemen were there. They had charge of the movies, and they knew exactly what happened. They don't like that demonstration. Now they are trying to make some of their own. But we weren't invited to it; purely ex parte. Why weren't we there? I say the objection is good.

Mr. Wolfe: There is no authority that I know of for making admissibility depend upon whether or not the test is ex parte or inter partes.

The Court: What difference is there between this kind of evidence and the witness telling in words what he thinks he saw at a particular experiment?

Mr. Byron: We have no opportunity to check.

The Court: You have not any opportunity to check if he conducts an experiment by himself and then relates from the witness stand what his conclusions or observations are, either.

Mr. Byron: That is correct.

The Court: Objection overruled.

Mr. Byron: I wish to note an exception, sir, which
600 I understand we will have all the way through the trial without repeating it.

The Court: Very well.

(Whereupon said articles, PLAINTIFF'S EXHIBITS 181-A and 181-B, were admitted in evidence.)

Mr. Wolfe: We will run these two in order, Plaintiff's Exhibits 181-A and 181-B.

(The projection of a moving picture reel was thereupon commenced.)

Mr. Stewart: Dr. Doan, the little handle which controls the amount of flux is not visible in the picture, is it, up at the top of the hopper?

The Witness: I do not know which that handle is.

Mr. Stewart: You do not know what that handle is for?

The Witness: I do not know where it is.

Mr. Stewart: All right. Now, at this point, the handle is still not visible, Doctor, is it? It is not visible in this picture either?

The Witness: I do not know.

Mr. Stewart: You cannot see the top of the flux
601 hopper, so you cannot see even if there is a handle there, can you, the way that picture is taken? That is correct, is it not?

The Witness: I do not see the top of the flux hopper, no, sir.

Mr. Stewart: What is your answer? I could not hear you.

The Witness: I do not see the top of the flux hopper. That is correct.

602 Mr. Stewart: Doctor, you see at the top there, that little handle that you can turn in about a 180-degree arc, do you not, at the top of the flux hopper, to the right, up on the righthand corner of the picture?

The Witness: I see it.

Mr. Stewart: Do you not know that that is what controls the amount of flux that is let down through the tube onto the weld?

The Witness: I imagine that is it.

Mr. Stewart: And that that is in the control of the operator? That is correct, is it not?

The Witness: Well, I suppose it is adjustable.

(Thereupon the running of the motion picture was completed.)

Mr. Stewart: Now, if your Honor please, may I ask Dr. Dean just one question, preliminary to making a motion with regard to this reel?

The Court: Yes.

Mr. Stewart: Dr. Doan, at the beginning of this
603 film, it stated that it was in accordance with standard operating practice, did it not, Lincolnweld standard operating practice? That is, the legend at the beginning of the film; do you recall that, at the very beginning?

The Witness: I am not sure what the phrase was.

Mr. Stewart: Will counsel agree as to that?

Mr. Wolfe: Yes.

Mr. Stewart: You were shown the Lincolnweld Manual,

the bulletin, which gave you instructions with respect to operating, were you not?

The Witness: Yes, sir.

Mr. Stewart: I am reading now from Bulletin LAF-1 which has already been attached to Mr. J. F. Lincoln's deposition as Plaintiff's Exhibit No. 9; and I read from that the following:

"When welding, use enough flux to submerge the arc only.

"There will be no harmful effect on the weld if the
604 arc does break out of the flux slightly once in a while."

Now, Doctor, there was considerably more flux on that seam than was necessary to comply with that instruction, was there not?

The Witness: I did not see the arc break out.

Mr. Stewart: But there was a lot more than was necessary to prevent it from breaking it out, was there not?

The Witness: Well—

Mr. Stewart: Is that not right?

The Witness: I think probably so.

Mr. Stewart: Now, if your Honor please, I move that this demonstration be stricken from the record.

Mr. Wolfe: May it please the Court, I would like to ask one or two further questions of Dr. Doan in that connection.

The Court: I do not quite understand the motion. I will permit further questions before I rule on it, and then I would like to have counsel elaborate on his motion.

Before ruling, I will permit further questions.

605 Mr. Wolfe: I would like to put just two questions.

The Court: Yes.

By Mr. Wolfe:

Q. The first question is this: Do those pictures, Doctor, as you saw them here, accurately depict the welding at the time they were taken?

A. They do.

Q. And the second question is this: How does the operation, as it appears in these motion pictures which we just saw here, compare with the Lincoln demonstration which you saw at Atlantic City?

A. The two are identical.

Mr. Wolfe: Those are all of the questions I wish to ask Dr. Doan in this connection.

Mr. Stewart: My motion, if your Honor please, is based on the fact that the legend at the beginning of the film said that it was standard operating practice, and they used about twice as much flux as was necessary to comply with standard operating practice.

The Court: Well, does that not go more to what significance may or may not be attached to the particular evidence, rather than to its admissibility or competence?

606 Mr. Stewart: Yes, I believe so.

The Court: Overruled.

Mr. Wolfe: Will you present that film, please?

609 (The projection of a moving picture reel then commenced.)

Mr. Stewart: He is adjusting the flux now, is he not, Doctor?

The Witness: I suppose so.

610 Mr. Stewart: Were there some flashes visible then, Doctor?

The Witness: Tiny ones.

Mr. Stewart: Just tiny ones? Was there not a larger one then, Doctor?

(There was no response.)

Mr. Stewart: This film is in black and white and not in color, is that correct?

Mr. Cahill: I submit the pictures speak for themselves in these regards.

The Court: Sustained.

(The projection of the film was then concluded.)

By Mr. Wolfe:

Q. As to this second reel, Dr. Doan, what do you have to say as to whether or not that accurately depicts the welding operation at the time the picture was taken?

A. It depicts it accurately.

Q. And what do you have to say as to how it compares or contrasts with the demonstration you saw at Atlantic City?

A. It shows the same conditions.

612 The trial of the cause convened at the plant of The Linde Air Products Company, 4400 Kennedy Avenue, East Chicago, Indiana.

Present:

Same as before.

PROCEEDINGS.

Mr. Wolfe: May it please the Court, we have sheets here similar to the ones we had at the first demonstration, that outline the demonstrations, or the tests which will be made, and I will ask Mr. Mason if he will distribute
613 those sheets at this time, so that each one present may have one.

(Said sheets were distributed.)

Mr. Wolfe: In order to avoid any confusion, we have numbered the demonstrations on these sheets consecutively with the first series. There were five of the previous demonstrations, and so we have started with No. 6 here this morning, to be conducted on this welding table here before your Honor.

This will be automatic welding on 3/4 inch plate, using Lincolnweld 660 flux, with a Lincolnweld welding head No. 17208-10. The welding head in this case is a 7/32 Lincoln electrode. Two passes will be made in making the weld, one on the first side, with 700 amperes, 34 volts, reversed polarity, direct current, with a travel speed of 12 inches per minute.

On the other side, it will be at 725 amperes, 35 volts, reversed polarity, direct current, and again, the travel speed will be at 12 inches per minute.

The plates have been bevelled with a 60-degree included angle, 1/8th of an inch deep, first side, and with a 70-
614 degree included angle, 3/8ths of an inch deep, on the opposite side.

There has been no other plate preparation, I believe.

Now, you may go ahead.

(Demonstration No. 6 was begun.)

GILBERT E. DOAN, called as a witness on behalf of the Plaintiff, having been previously duly sworn, resumed the stand and testified further as follows:

Direct Examination (Continued) by Mr. Wolfe.

Q. Dr. Doan, about half way along the weld there, the operator had to stop his machine.

What was it that occurred there?

A. I don't know.

Mr. Wolfe: What was it, Mr. Roberts?

Mr. Roberts: The current setting was a little high, and the plates were a little bit loose, inadvertently, and the weld burned through. It was not intended that that should happen, at all.

We have run several pairs of these plates, with apparently the same setup.

Now, what shall we do on the other side? It is not
615 practical to weld over this, now.

Mr. Wolfe: Just weld up to it, and then stop, and then start in again.

(The demonstration was then proceeded with.)

Mr. Stewart: Mr. Wolfe, do you mind if I ask one question of Dr. Doan?

Mr. Wolfe: Go right ahead.

Mr. Stewart: Dr. Doan, this depression which is shown right here in the center, where apparently the operation stopped, is typical of an arc crater, is it not?

The Witness: That is caused by exactly the same conditions as the 2-inch deep fissure which we have exhibited.

Mr. Stewart: If your Honor please, may I have an answer to my question? I will ask the question again.

That is a typical arc crater in arc-welding, is it not?

The Witness: It is not.

Mr. Stewart: It is not?

The Witness: No.

Mr. Stewart: It is the same shape, is it not?

616 The Witness: I would not like to say about that.

Mr. Stewart: You have written about craters in arc-welding, have you not?

The Witness: Yes.

Mr. Stewart: And that is not an arc crater, you say?

The Witness: That is not.

Mr. Stewart: That is all.

(This concluded the first part of Demonstration No. 6; and the demonstration then continued, on the other side of the plates.)

Mr. Wolfe: While the operation is in progress this time, Dr. Doan, will you measure the height of the flux burden.

The Witness: Yes, sir, I will. Shall I measure it at the tube, or at the electrode?

Mr. Wolfe: At the electrode.

(The demonstration was thereupon proceeded with.)

By Mr. Wolfe:

Q. Dr. Doan, what were the heights that you measured?

A. At the electrode, 1 inch; and at the bottom of the tube, 1 3/4 inches.

617 Q. Is there any adjustment for the height of the tube on that machine?

A. No, sir, there is not, so far as I am able to see.

Mr. Stewart: Mr. Wolfe, may I ask Dr. Doan a question?

Mr. Wolfe: Surely.

Mr. Stewart: Dr. Doan, that hissing, crackling noise is the same as the noise you hear when you hear an electric arc in welding, is it not?

The Witness: I would not like to judge from the noise as to what is going on under there.

Mr. Stewart: I will put the question this way: It is similar to the noise which you hear when you hear an open arc, one that you can see, is it not?

The Witness: I would not like to base my judgment on the phenomena on what is evidenced here.

Mr. Stewart: May it please the Court, may I have an answer to my question?

618 The Court: I think that question can be answered.

The Witness: There may be some similarity, yes, sir.

Mr. Stewart: That is all.

(The demonstration was thereupon further proceeded with to a conclusion.)

Mr. Wolfe: Now, would you gentlemen be good enough to stand back a little bit, so that these men will have a little elbow room, in changing the plates here.

619 I call your Honor's attention to the backing bar

they are putting on now for the next demonstration. That is the backing bar.

While they are making the set-up for the next demonstration, I will offer the plate which was welded in demonstration No. 6 as Plaintiff's Exhibit No. 182. Do you care to have a sample of the flux or the rod used, Mr. Byron?

Mr. Byron: I think so, yes.

Mr. Wolfe: There are some bottles here. You can take a sample if you like.

The Court: Is there any objection to the admission of the exhibit? Did you offer the exhibit?

Mr. Wolfe: Yes, I offered it.

Mr. Byron: No objection.

The Court: It is admitted.

(Whereupon said plate was marked PLAINTIFF'S EXHIBIT 182 and received in evidence.)

Mr. Wolfe: Now, demonstration No. 7 will be an automatic weld on a half-inch plate with a single pass. In the first third of the plate they will use Unionmelt No. 20, 620 in the second third of the plate, Lincolnweld 660, and in the final third of the plate clay flux of the same analysis as that used in demonstration No. 4 the other day. In order to get all three of those on there and at the same depth, a set of metal sideboards has been provided, and the operators will fill those sideboards, or the channel between them, with the fluxes that I have mentioned.

In this case the rod used is an Oxweld No. 36 quarter-inch rod. The plate has been beveled with a 60-degree included angle, with a three-sixteenths root, and the current which will be used will be 850 amperes at 28 volts, reverse polarity, direct current. The travel speed will be 16 inches per minute and the height of the sideboards which will be used as a level for the flux is one and one-quarter inches.

Mr. Stewart: May I ask what is on the other side, the under side? Is there a hand bead? Is there a fit-up?

Mr. Wolfe: Is there a hand bead?

Mr. Roberts: No. No fit-up. No hand bead at all. 621 It is a single bevel with a root face on a copper groove.

Mr. Wolfe: There is a copper backing-up bar on the back side.

Mr. Stewart: May I ask one question of Dr. Doan before we begin?

The Court: Yes.

Mr. Stewart: I do not mean to spoil the smooth ar-

rangement of the flux, but if you draw this pen or an electrode through the Unionmelt flux it would fall around behind it and fall in that space, would it not, like this (Indicating)?

Mr. Wolfe: Let the record show he has left a groove in the top where he drew his pen along.

Mr. Stewart: In the Lincolnweld flux, Doctor, a similar thing happens, does it not? There is a groove, and you will notice how the particles fall in behind the pen, whereas in the clay flux you leave a canyon; it does not fall in back around the pen, does it, Doctor?

The Witness: The difference to me seems very slight.

Mr. Stewart: The difference between what I did
622 in the Unionmelt and the Lincolnweld, and the clay, with respect to the appearance afterwards, seems very slight to you?

The Witness: Yes.

Mr. Stewart: That is all.

(The welding demonstration was then given.)

Mr. Stewart: One question, Dr. Doan. After the electrode was passed through all three types of flux, do you note with respect to the clay flux, as you described it before, only a slight difference so far as the particles falling back into the groove is concerned?

The Witness: By no means.

Mr. Stewart: Is it very different?

The Witness: Definitely.

Mr. Stewart: And the molten slag, Doctor, is visible for the entire 12 inches underneath that clay flux weld? You can look down there still now and see the red-hot slag, is that right? I mean, red hot, not molten.

The Witness: Yes, there is something hot down there.

Mr. Stewart: As a matter of fact, you can see little particles when you can see through?

623 The Witness: Yes.

Mr. Stewart: The same is true in each of the others but you cannot see it, is that right, the same length of time afterwards?

The Witness: What do you mean?

Mr. Stewart: The layer of slag is red hot under each one of those in the same manner.

The Witness: It is red hot under each one of those.

Mr. Stewart: Right.

Mr. Wolfe: I offer this plate in evidence as Plaintiff's Exhibit 183.

Mr. Byron: No objection.

The Court: It may be admitted.

(Whereupon the said plate was marked PLAINTIFF'S EXHIBIT 183 and received in evidence.)

By Mr. Wolfe:

Q. Dr. Doan, do you see any difference in appearance between the welds made with the Unionmelt and the Lincolnweld?

A. I do not.

The Court: I did not hear the question.

(The record was read.)

624 Mr. Wolfe: I do not have any further questions. Do you have any more?

Mr. Stewart: May we have a sample of the slag from each section of this demonstration marked?

Mr. Wolfe: Yes. I offer the slag from the Union-
625 melt portion in evidence as Plaintiff's Exhibit 184.

Mr. Stewart: Consisting of four pieces.

The Court: It may be admitted.

(Whereupon the said slag was marked PLAINTIFF'S EXHIBIT 184 and received in evidence.)

Mr. Wolfe: I offer in evidence as Plaintiff's Exhibit 185 the slag from the Lincolnweld section, consisting of six pieces.

The Court: It may be admitted.

(Whereupon the said slag was marked PLAINTIFF'S EXHIBIT 185 and received in evidence.)

Mr. Wolfe: I offer in evidence as Plaintiff's Exhibit 186 the slag from the clay section, consisting of four pieces.

The Court: It may be admitted in evidence.

(Whereupon the said slag was marked PLAINTIFF'S EXHIBIT 186 and received in evidence.)

The Court: Is there anything further, gentlemen?

Mr. Stewart: One more question. Dr. Doan, will
626 you examine those pieces and count the holes that appear in first the Unionmelt and then the Lincolnweld flux?

Mr. Wolfe: I think they speak for themselves in that regard. They are in evidence.

M. Stewart: Do you object to that?

Mr. Wolfe: Yes. They are in evidence. There is no point in that.

The Court: Are you insisting upon your answer, Mr. Stewart?

Mr. Stewart: No sir. I think it is apparent.

Mr. Wolfe: I have nothing further, if the Court please.

Mr. Stewart: Mr. Wolfe, could we see the back side of the weld?

Mr. Wolfe: Surely.

Mr. Stewart: Dr. Doan, will you come here for one moment and look underneath this electrode? That which I say to you just fell off as I touched it, underneath the electrode—do you know what that is?

The Witness: No, I do not.

Mr. Stewart: Will you pick it up and examine it?

627 The Witness: Well, I would say it is an accretion of something picked up on the entire run.

Mr. Stewart: The last flux that that electrode went through was the clay flux, was it not?

The Witness: Yes, but that does not indicate that this necessarily came from the last flux.

Mr. Stewart: My question was, the last flux that the electrode went through was the clay flux, was it not?

The Witness: It was.

Mr. Stewart: Doctor, notice the shape of that, and that little streamer off it. Can you tell whether that is a streamer of molten flux?

The Witness: I do not know what it is.

Mr. Stewart: It is porous, full of holes, is it not? May I let the Judge see it.

It has a grayish powder on the outside, has it not?

The Witness: Yes.

Mr. Stewart:—You recall your testimony yesterday

628 about inserting a wire into the molten flux during the welding operation with Unionmelt, and drawing it out and having a streamer of flux attached to it?

The Witness: Well, this is not something like that.

Mr. Stewart: It is not anything like that at all?

The Witness: No.

Mr. Stewart: I ask that this—it will be rather difficult to mark this as an exhibit, because it will fall apart surely.

Mr. Cahill: Dr. Doan, you are shaking your head in answer to some of these questions. You will have to answer audibly. The reporter does not get that.

Mr. Stewart: I do not know how that could be preserved, because in an envelope it will crack up probably.

Mr. Byron: Put it in a box.

Mr. Stewart: I ask that this be marked as Defendant's Exhibit 91.

(Whereupon the said article was marked Defendant's Exhibit 91 for identification.)

629 Mr. Wolfe: Nothing more for plaintiff.

The Court: Anything further from defendants?

Mr. Stewart: Dr. Doan, what would you say about the penetration in the last portion of the weld, looking at it from the underside?

The Witness: Just viewed superficially, it is almost complete but not quite.

Mr. Stewart: That is all.

The Court: Is there anything further from Mr. Stewart or Mr. Byron?

Mr. Stewart: No.

The Court: It is eleven o'clock, gentlemen. I think we should proceed as soon as we get back to Hammond.

630 And thereupon the trial of the case was resumed in the Court Room, at the United States Court House, Hammond, Indiana.

Mr. Wolfe: May it please the Court, I have here two items that were marked for identification as Plaintiff's Exhibits in the course of depositions. One is two reels of motion picture films, which were marked at that time as 68-A and 68-B, and the other a set of still photos which were marked Plaintiff's Exhibit 69.

It is agreed, is it not, Mr. Byron, that those motion pictures and still photos accurately show the welding demonstration that was made at the Graver plant pursuant to Court Order?

Mr. Byron: That is correct.

Mr. Wolfe: I am going to offer these in evidence at this time, but of course with the understanding, as I said in our opening, they are simply for the purpose of showing what was done at the demonstration and not that we accept those as accurately representative of the

631 Defendant's practice.

I offer the motion picture films in evidence as Plaintiff's Exhibits 187-A and 187-B (68-A and 68-B), and I offer in evidence as Plaintiff's Exhibit 188, the set of still photos which were individually marked on the depositions as 69-A to 69-AA.

The Court: Any objection?

Mr. Byron: No objection.

The Court: Admitted.

(Whereupon said films, PLAINTIFF'S EXHIBITS 187-A and 187-B and 188 were admitted in evidence.)

Mr. Wolfe: And as the next step, your Honor, we would like to run these motion picture films which have just been offered.

Will you set up the machine, please.

(Two reels of motion pictures were then shown, without questions by counsel, or comment by the witness.)

Mr. Byron: Mr. Wolfe, may I just make one statement at this time.

I believe it is agreed that the flux which was used in the Graver demonstration on May 21, 1946, was the
632 standard 660 Lincolnweld flux, and that it was regular.

Mr. Wolfe: Yes.

Mr. Byron: And that Plaintiff had a sample of the flux, and tested it, and found it to be regular.

Mr. Wolfe: Yes, that is correct.

Mr. Byron: Thank you.

Mr. Wolfe: Now, if it please the Court, at this time, with the permission of the Court I would like to withdraw Dr. Doan from the witness stand for a few moments, in order to take the testimony of another witness, just very briefly.

Mr. Byron, as I understand it, is agreeable.

Mr. Byron: Yes, I might mention one other thing, your Honor, in connection with this demonstration at the Graver plant on May 21st.

I believe that the Plaintiff reached the conclusion that, on the plate as welded, the welds were about perfect.

Mr. Wolfe: I think that they were satisfactory welds.

Mr. Byron: Very well.

633 Mr. Wolfe: Take the stand, please, Dr. Cumming.

ULMONT O. CUMMING, called as a witness on behalf of the Plaintiff, having been first duly sworn, was examined and testified as follows:

Direct Examination by Mr. Wolfe.

Q. Will you give us your full name please.
A. Ulmont O. Cumming.
Q. What is your residence?
A. 149 East 63rd Street, New York City, New York.

Q. What is your business?

A. I am president of International Service Corporation, the business of which is patent and trade-mark investigation work.

Q. How long have you been in that work?

A. Twenty years next May.

Q. What has been the scope of your work during that period?

A. Our clients number about 300 to 350 patent firms, and about 200 companies that have their own patent departments.

The scope of the work has been investigative work in
634 connection with prior use investigations, trade-marks, licensing, the buying of patents, and infringements.

Q. Did you receive an instruction from me to make an investigation at the plant of the defendant here, the Graver Tank & Manufacturing Company, in East Chicago, Indiana, to determine whether or not they were using the Lincolnweld process?

A. I did; I received those instructions in August of 1945.

Q. Now, I wish you would tell the Court in your own words what you did and what you saw, pursuant to that instruction.

A. Pursuant to those instructions, I made contact with Mr. Cornwell, who was then in New York, and arrangements were made to visit the Linde plant at Niagara Falls, and I met Mr. Keir of that company and watched during the day the process of Unionmelt welding in their plant at Niagara Falls. In other words, it was a demonstration in their laboratory of the Unionmelt process.

About a month later—I think the 19th of September—I came to Chicago. I telephoned the Chicago office of the Lincoln Company, told them I would like to see a demonstration of one of their machines. I spoke to Mr. Ed.
635 Hess. Mr. Hess said that the nearest one I could possibly see was in the Graver Tank & Manufacturing plant at East Chicago, Indiana.

I asked him how such arrangements could be made. He told me that they had taken so many visitors through that plant in demonstrating that welding process that he would be very much embarrassed about taking any more, but suggested I telephone Mr. James Quigley, in charge of welding.

I did; I called Mr. Quigley right away. Mr. Quigley said

if I would come down the next morning any time during the morning he would be glad to show me the process the Graver plant was using.

About eleven o'clock the next morning, I met Mr. Quigley. We went into the welding shop, the big welding shop they had at that time. They were welding a tube that was about 50 to 52 inches in diameter and 50 feet long. They were welding it longitudinally, that is from one end to the other, inside.

Mr. Quigley and I stood close to the end of the tube. I was closest, then he was standing just to my left.

At the time I approached the tube, they still had about five feet of welding to complete; so I stood there with
636 him, watching, asking a few questions of him, why this was done and why the other was done, and they were welding in such a way that the electrode was submerged in the flux, and during the passage of the welding machine for the five feet I saw only two very small flames, and very little smoke.

The two flames I saw disappeared almost immediately, just flared up and flared back. There were no sparks, nothing blinding, and no flame other than what I have just mentioned.

After the welding was finished, he removed the flux that wasn't used—or the man did that was welding—then knocked off the molten flux and showed me the weld.

I asked if that was a normal weld, or the one they usually do, or was there any difference if I would wait a while to see some more. He said if I stayed there all day I wouldn't see anything different, that they were all the same.

Q. Did the operator, or anyone around the shop wear any eye protection?

A. Not at all.

Q. Wear shields or goggles?

A. None.

Q. You saw the motion pictures which were just projected here in the Court Room, did you?

637 A. Yes, sir.

Q. How did the appearance of the operation in the motion picture appear or compare with what you saw at the Graver plant?

A. Nothing like it. I mean by that to the extent that the picture showed a great deal of spark and a great deal

of flame, and that flame and that spark was not in evidence when I was there.

638 Q. Did you last night have an opportunity to see projected the motion picture films, the two reels which have been received here in evidence as Plaintiff's Exhibits 181-A and 181-B?

A. Yes, sir.

Q. I beg your pardon?

A. I did.

Q. How did the Lincolnweld welding operation shown in those pictures compare with what you saw at the Graver plant?

A. They were practically identical.

Mr. Wolfe: That is all.

Cross-Examination by Mr. Byron.

Q. Mr. Cumming, the extent of the welding which you saw at the Graver plant on the day of your visit was five feet of welding, is that correct?

A. Approximately five feet, from the inside of the tube to the end.

Q. And that was inside welding?

A. Yes, sir.

Q. You did not see any outside welding?

A. I did not see any. I asked them if there would be any difference if I stayed, and he said there would be

639 none.

Q. That is pure hearsay. I am speaking about what you saw.

A. I did not see any other except—

Q. You saw five feet of welding?

A. That is right.

Q. And that is all there was to it?

A. That is all.

Q. Then you of your own knowledge do not know whether or not five feet of welding was truly representative of the commercial welding which the Graver Company carries on right along?

A. Not to my knowledge; only in answer to the question which I asked Mr. Quigley.

Q. Now, in that five feet of welding you did see some evidence of an arc, did you not?

A. You mean by an arc, sparks?

Q. That is right.

A. No sir. I only saw two small flames appear and then immediately disappear.

Q. What were those, if you know?

A. I would say that was probably caused by—I am not an expert in welding, but I would say it was probably caused by burning gas or the flux being burned
640 down below.

Q. Who told you that?

A. It was not told to me by anyone. I have read over the process and from my study of it or knowledge of it in Niagara Falls, that is why that flame is there and why it should disappear.

Q. What instructions did you receive from Mr. Cornwell about visiting the Graver plant?

A. I received none from Mr. Cornwell.

Q. From whom did you receive instructions?

A. From Mr. Wolfe.

Q. And what were those instructions?

A. To visit the Graver Tank & Manufacturing Company for the purpose of obtaining information as to the welding process which they were using, as it was desired for the purpose of an infringement suit under the Jones patent.

Q. I suppose Mr. Wolfe made it clear to you that he hoped you would not see any sparks at all, did he not?

A. No, sir. He did not make anything clear. He merely transmitted instructions by letter, and I had no instructions from him verbally whatsoever.

Q. Where were you with respect to this pipe, 50-inch pipe, that was being welded at the time you were at
641 the plant?

A. I was right at the end on the righthand side.

Q. How long was the pipe?

A. I would say it is about 50 feet long.

Q. Were you 50 feet from the spot of welding, or were you right at the spot of welding?

A. I was at the spot of welding.

Q. Were you on the outside of the tank or on the inside of the tank?

A. I was on the outside of the tank.

Q. And the welding was going on in the inside?

A. That is right.

Q. How did you know about sparks flying or what the condition of the weld was?

A. I could see, sir.

Q. Now, did you see through the metal plate? Is that the idea?

A. See through the metal plate?

Q. That is right.

A. I could see—what metal plate do you refer to?

Q. I suppose it was metal that was being welded, was it not?

A. I was looking on the inside, not from underneath.

Q. Now, just what was being welded? You said, a
642 longitudinal seam?

A. That is right.

Q. And how much flux was being used?

A. You mean, as to the depth?

Q. That is right.

A. I would say—this is purely guesswork, because I have no other way of knowing it except giving you a guess—it was somewhere between an inch and two inches, but it was to the extent that the electrode was almost submerged.

Q. The electrode was almost submerged?

A. Yes. You could just barely see the end of it coming out of the holder.

Q. Do you mean to say that the end of the electrode was not inside or within the flux?

A. Oh, yes. I am talking about the end of the electrode that is held in the holder, the upper end. The bottom end of the electrode where the welding takes place was completely submerged.

Q. What was the plate thickness?

A. I did not ask them.

Q. Didn't you observe?

A. Well, I did observe it, but I did not pay a great deal of attention to the technical aspect of what was
643 being welded, and why, or the thickness of it; only I looked at the length and the diameter.

Q. Who was the operator?

A. I do not know the operator. Mr. Quigley was standing beside me.

Q. You made no inquiry.

A. No, sir.

Q. Did you have to secure a pass to get into the plant, or did you just call Mr. Quigley?

A. When I came there Mr. Quigley came to the entrance

and met me, and as I recall it he arranged for the pass himself.

Q. Was the welder between you and the spot which was being welded?

A. No, sir; he was to the left of the entrance of the tube, and I was to the right.

Q. So that you were looking directly at the point where the welding was being done, were you?

A. Yes, sir.

Q. Was the chute down through which the flux passed, in front of you?

A. Yes, sir.

Q. Just as these pictures were taken?

A. Just as these pictures were shown, yes, sir.

Q. So that there might have been considerably more
644 flashing, and the flashing would have been more or less obscured by the chute; that is correct, is it not?

A. I do not think so, no, sir, because of the fact that a lot of flashing would have been more in evidence than ever, inside of a container like that.

Q. But the chute undoubtedly obscured a part of your vision, did it not?

A. Only slightly; but when the welding reached its end, I peered over the top of the chute, and over the top of the guard, and watched it from a vertical position.

Q. But the fact still remains that if the chute was interposed between your eyes and the spot of welding, that spot would be obscured to a certain extent; that is correct, is it not?

A. It would be obscured by the flux also.

Q. And it would obscure any sparks and flames, would it not?

A. No, sir, it would not obscure—well, I do not know what you mean by "would obscure the sparks." There were no sparks, and there were only just two slight flames, in a five-foot passage.

Q. Can you see through metal?

A. No, sir.

645 Q. Well, that is the point that I am raising.

That is a metal tube, down through which the flux passes, and if that tube were interposed between your vision, your eyes and the point where the welding was going on, it would not be so easy to see what sparks or flashes there were, would it?

A. Oh, I see what you mean now. I had, at the beginning, probably about five to four or four and a half feet, but at the end, I could see clearly over the field of welding.

Q. Oh. So really, all that you saw, looking over the shield, was about half a foot?

A. I would say—

Q. (Continuing) That is, your vision was just clear for about a half a foot; is that correct?

A. At half a foot, I could see vertically; otherwise it was obscured; but there were no sparks or flashing at any time during that transit.

Q. You are talking about the half foot, now, are you?

A. I am talking about the five feet.

Q. You could not see so well during the four and a half feet of travel, could you?

646 A. I could see excellently well, as to the welding operation.

By Mr. Byron:

Q. You do this for a living, do you not?

A. I certainly do.

Mr. Byron: That is all.

Mr. Wolfe: May it please the Court, I have one further question that I neglected to ask.

Redirect Examination by Mr. Wolfe.

Q. Mr. Cumming, did you see the demonstration this morning?

A. Yes.

Q. That was given for the Court?

A. Yes, sir.

Q. How did the operation there, with the Lincoln 647 flux, compare with what you saw at the Graver plant?

A. It was just about the same, except I do not think I saw even as much flame this morning.

Mr. Wolfe: That is all.

The Court: Are there any further questions of the witness?

Mr. Byron: That is all.

(Witness excused.)

Mr. Wolfe: Dr. Doan.

GILBERT E. DOAN, called as a witness on behalf of the plaintiff, having been previously sworn, resumed the stand and testified further as follows:

Direct Examination (Continued) by Mr. Wolfe.

Q. Dr. Doan, you saw these movies that were projected for the Court just a few moments ago here, did you not?

A. Yes, sir.

Q. How did the welding operation which you saw in those movies compare with the Lincoln demonstration which you saw at Atlantic City?

A. They were entirely dissimilar in the quantity of 648 light, spa ks and smoke emitted.

Q. You were present at the demonstration that was made for the Court this morning, of the Lincoln welding process and flux, were you?

A. Yes, sir.

Q. How did that operation compare with the Lincoln Company demonstration at Atlantic City?

A. It was of the same appearance exactly.

Q. Will you tell us whether or not there is any useful purpose in welding, to be served by cutting the flux burden in this Lincoln process, down to a point where there is just the bare minimum amount shown in these movies?

A. We found it useful in revealing the contact and immersion of the electrode in the molten pool; but otherwise, it is a very dangerous procedure, to skate on such thin ice.

Q. That is, in commercial practice it would be a dangerous thing to do, would it?

A. It would be a very dangerous thing to do, yes, sir.

Q. Is there any improvement in the weld to be had, in that way?

A. No, sir.

Q. Is there any saving in cost to be accomplished in 649 that way?

A. No, sir, there is not, because the unfused flux is recovered, entirely.

Q. Now, Dr. Doan, in checking over the testimony of yesterday, I discovered that I had left one part of an answer of yours hanging in the air. You had pointed out to the Court that there were two references in the patent

in suit to the phenomena involved in the process, the electrical phenomena, and I questioned you with respect to the first, but did not go ahead with the second.

The second one to which you called our attention was, I believe, in the last paragraph, in the first column on page 4 of the patent.

A. Yes.

Q. Is that correct?

A. That is right.

Q. Would you explain just briefly, please, Dr. Doan, the significance of that material?

A. In explaining the essence of the process on the first chart, I pointed out that the current—

Q. Pardon me, Doctor, but are you referring now to Exhibit 167?

A. Yes, sir.

Q. Continue.

650 A. (Continuing) —is carried from the electrode to the plates through a pool of molten welding composition.

I explained that this pool is ionized throughout, and that conduction of the current through the pool takes place through the entire pool, both the liquid part and any part that may be present at the core of the pool.

651 The patent speaks of this on page 4, column 1, at line 54, and describes experiments which the inventors carried out with two extreme types of welding compositions, one common salt, sodium chloride, and the other sand.

They found that with the former, the current was conducted over so wide a cross section of the molten material that they got little if any melting; but that, in the second experiment, in which they used sand, largely or principally silica, the conduction was limited to such a narrow zone that almost no material outside of the electrode participated in the pool, and in the liquid conduction through the pool.

These two types of electrical phenomena, the inventors speak of in this specification.

In the first one they say:

"Several circumstances show clearly that our process does not depend upon the formation of an arc of the usual type."

Then they go on to give some support for that knowledge, or understanding that they had achieved at that time, of that phenomenon.

Then in the following paragraph they discuss the
652 influence of the conductivity as a liquid which supplies an important part of the action of the welding pool, in heating and transferring metal.

Q. In connection with that first items as to the arc of the usual type, are you familiar with a phenomenon in arcs known as aureole?

A. Yes, I am.

Q. What is it? Will you tell us about that.

A. In many metal arcs in air, metal is vaporized as a vapor and mist from the hot zone, and where it comes into contact with the air the two combine and burn to form a hot enclosing gas envelope around the arc proper. This is called the aureole and is characteristic of many types of arc.

It reflects back to the arc its important quantities of heat, contributes to the energy of the arc important amounts in that way. It likewise acts as a transition stage between the arc discharge proper and the surrounding gaseous environment and air.

Q. Is there any such phenomena present in the welding process of the patent in suit?

A. Since the phenomena takes place in this pool, there is no access of air and this phenomena cannot occur.

Q. Now, another matter: You have published some studies, have you not, on arc blast?

A. Yes, I have.

653 Q. What in general was the character of your findings along that line?

A. We knew that in ordinary arc-welding a pressure like that of a fire hose comes from the lower end of the electrode and sweeps the liquid metal back out of the crater to the weld proper. It is important in open arc-welding. It is one of the effective influences in forming a crater. The crater provides penetration.

So, we wanted to measure it quantitatively, and we devised a pendulum as one of the electrodes that would swing in proportion to the pressure exerted by the arc blast. We calibrated that pendulum so we could measure exactly, by the amount of its depression, how much pressure was exerted against it.

So we took electrodes, bare and coated electrodes, and, with various currents flowing, measured the amount of depression as an indication of the amount of pressure.

We found with current of 100 amperes we would get a force exerted of perhaps one gram, that is, a thousand milligrams. When we went up to 180 amperes we got forces of two grams—I believe it was 2200 milligrams—and we plotted curves showing the increase of that blast pres-
654 sure against the current flowing in different atmospheres, of one curve for each atmosphere.

Q. Did you ever find what caused that blast pressure in ordinary open arc welding?

A. No, I did not.

Q. Do you know anyone that has?

A. No, I do not. It is important, but it hasn't been determined.

Q. What have you found as to any similar blast pressure in the process of the patent in suit?

A. Well, when you get a current flowing through a pool in the neighborhood of a thousand, two thousand, three thousand amperes, the blast pressure is tremendous and should be measured in pounds.

Whether the blast pressure doesn't exist in this discharge or whether the viscous pool is able to retain it, I don't know; but it is quite a different situation.

Q. In the course of your testimony yesterday, you were referring to high speed welding and thin plate, and I believe you referred to speeds of 180 feet per hour. Do you want to make some correction on that?

A. It should be 180 inches per minute.

Q. Yesterday, Dr. Doan, we had here a set of motion pictures which were taken of welding with the Lincoln
655 weld process in the demonstration room. Were still photographs made at that same time—

A. Yes, they were.

Q. —when those motion pictures were made?

A. Yes.

Q. Will you say whether or not you recognize these still photos as showing the operation at that time (handing photographs to the witness)?

A. Yes. These are the same ones.

Q. What do you have to say as to whether or not they accurately portray the operation?

A. Why they do, yes.

Mr. Wolfe: I offer this set of photographs in evidence as Plaintiff's Exhibit 189.

Mr. Stewart: No objection.

The Court: They are admitted.

656 (Whereupon said photographs, PLAINTIFF'S EXHIBITS NOS. 189-A to 189-W, both inclusive, were admitted in evidence.)

By Mr. Wolfe:

Q. At the same time that those photographs were made at the demonstration room, Dr. Doan, were you present during the taking of the motion pictures of any other welding operations than the Lincolnweld?

A. Yes, I was.

Q. What did that include?

A. One of them was a one-inch plate in which the flux covering part of the weld was Unionmelt and covering another part was the clay flux.

Q. What were the welding conditions of that weld?

A. 1500 amperes was used, with a speed of 11 inches per minute. The first third of the plate was Unionmelt 20 and the next third was the clay flux. The burden was three inches wide and one and a half inches deep.

I have some notes about the finished welds. The Unionmelt weld was a normal smooth weld. The clay flux weld was extremely rough, and the smoke and dust that we have seen with the clay flux is recorded here also.

Q. Did you also see the photographing of any hand
657 welds at that time?

A. Yes. Mr. Roberts did a little welding on a one inch plate with 180 to 190 amperes and 24 volts, using an Allis Chalmers electrode, and a little welding with the bare electrode, one-eighth inch diameter, with 140 amperes.

Q. I think you spoke of the Unionmelt and clay flux covering respectively one-third of the plate. Did you mean one-third or one-half?

A. That is what my records show.

Mr. Wolfe: The motion picture and still pictures which were taken of those operations are those previously identified as Plaintiff's Exhibits 152, being the motion picture, and Plaintiff's Exhibits 153 to 157 both inclusive, which are the stills. They were offered in the course of Mr. Kennedy's testimony and the Court reserved ruling on them in view of the fact that Mr. Kennedy had not been present when they were taken.

They are reoffered at this time.

Mr. Stewart: No objection.

The Court: They may be admitted.

658 (Whereupon said motion picture and still pictures, PLAINTIFF'S EXHIBITS NOS. 152 and 153 to 157, both inclusive were admitted in evidence.)

659 Mr. Wolfe: Have you had an opportunity, Mr. Byron or Mr. Stewart, to read over this memorandum on conduction of electric current in an ionized gas or liquid?

Mr. Stewart: Yes, and I have an objection to it.

Mr. Wolfe: You have an objection to that?

Mr. Stewart: Yes.

By Mr. Wolfe:

Q. Will you say, Dr. Doan, who prepared this memorandum that I hand you?

A. I have been responsible for its preparation.

Q. Will you state for us what the facts are as to the conduction of electric current in an ionized gas or liquid, and in doing so you may, for the sake of convenience and expedition, refer to that memorandum.

A. I do not like to read the whole thing.

Q. I do not like to have you, but Mr. Stewart seems to want to have it that way.

Mr. Stewart: May I explain my objection to this, your Honor?

The Court: Yes. I have not ruled. Are you insisting on its admission?

Mr. Wolfe: Yes, your Honor.

660 The Court: I will hear your objection.

Mr. Stewart: This was offered yesterday as a treatise prepared by the Doctor with nothing controversial in it at all, and a copy handed to the Court. I asked whether we could see it before ruling was made, so we could determine whether there was anything controversial.

It purports to be a scholarly treatise on the conduction of electric current in an ionized gas or liquid, and then the last page sells the patent in suit, to fit the theory.

I object to that as an improper method of introducing evidence.

The Court: Are you objecting to the portion which has to do with any reference to the patent in suit, only?

Mr. Stewart: I object to it on that ground, as something which was handed to the Court as a treatise prepared by this gentleman. He can testify—

The Court: You are not objecting to the entire document?

Mr. Stewart: No. I cannot prevent him from read-
661 ing this if he says that is what he thinks, obviously. I do object to its going in as a document in this case, or some treatise obviously prepared for the case.

The Court: Up to a certain point, as I understand it, you do not object. There are some portions of it you are not objecting to, if I understand you. You said up until the last page it was a treatise on certain matters.

Mr. Stewart: It purports to be just merely a treatise.

The Court: Up to that point, is it?

Mr. Stewart: Yes. I do not agree with it, but it is. Mr. Wolfe said, of course, there would be nothing controversial in it.

Mr. Wolfe: I will withdraw that statement, because there obviously is a controversy as to it, and I will offer it simply through Dr. Doan here as an exhibit, being a document which he has prepared and which we will offer that way rather than having him read it.

The Court: I am wondering what difference there is whether he reads it or whether it is introduced as
662 something which he prepared and which he says he is responsible for and will be his testimony, and on which you can cross-examine.

Mr. Stewart: I am perfectly content with that, your Honor, in so far as it is brought out that this is not just a non-controversial treatise prepared by the Doctor, having nothing to do with this unit. It is prepared for this suit, obviously.

The Court: With that explanation of counsel the document will be admitted.

Mr. Wolfe: That will be Plaintiff's Exhibit 190.

(Whereupon the said document was marked PLAINTIFF'S EXHIBIT 190 and received in evidence.)

663 Mr. Wolfe: May it please the Court; there are sev-
664 eral items that have been previously marked for identification, which I would like to offer in evidence at this time.

In particular, Plaintiff's Exhibits 133 to 150 both inclusive, those being plates, specimens of flux, rods steel wool and so forth, which were marked for identification at the first demonstration.

The Court: Is there any objection?

Mr. Byron: No objection.

The Court: Admitted.

(Whereupon said articles, PLAINTIFF'S EXHIBITS NOS. 133 to 150, both inclusive, were admitted in evidence.)

Mr. Wolfe: I also offer in evidence Plaintiff's Exhibit No. 151, that having been the program of the first demonstration.

Mr. Byron: No objection.

The Court: Admitted.

(Whereupon said document, PLAINTIFF'S EXHIBIT NO. 151 was admitted in evidence.)

Mr. Wolfe: I also offer in evidence as Plaintiff's
665 Exhibit No. 191, the program of the second demonstration this morning.

Mr. Byron: No objection.

The Court: Admitted.

(Whereupon said document, PLAINTIFF'S EXHIBIT NO. 191, was admitted in evidence.)

Direct Examination (Continued) by Mr. Wolfe.

Q. Now Dr. Doan, I have just one further question that I would like to put to you.

You were not at the demonstration at the Graver plant, of which we saw the movies this morning, were you?

A. No.

Q. Well now, referring to that demonstration, assuming first that the motion pictures that we saw this morning did accurately depict the demonstration, and second, assuming that the welds made were of good appearance and sound structure, and having in mind the experimental work which you have done with the Lincolnweld process, and Lincoln flux:

What is your opinion as to whether or not the electrode, or the rod, was immersed in a liquid pool during the
666 welding in the Graver demonstration?

A. It unquestionably was immersed.

Mr. Wolfe: That is all.

Cross-Examination by Mr. Stewart.

Q. Well then, I will put the question to you this way: From a commercial practice point of view, Doctor, does it make any difference whether you use just enough flux

to cover that display that is visible, or whether you use more than enough?

667 From a commercial point of view, is there any reason why someone should use just enough, rather than more than enough?

A. If by "just enough" you mean what were shown in the motion pictures of the demonstration at the Graver Company, I would say that was very dangerous and undesirable.

668 Q. That was undesirable why, for fear you might get a poor weld?

A. Yes.

Q. All right, let's put a little more on so that you get beyond that danger point, then is there any commercial reason for using any more flux on that?

A. That is an indefinite question.

Mr. Stewart: I would like an answer to it.

The Court: Read it, so he will have it in mind.

(The question was read.)

A. If by the "danger point" you mean the point at which the pool becomes inadequate to impress the electrode, and you go beyond that, then I would say there is no further advantage.

By Mr. Stewart:

Q. There is no further advantage. This flux, in the case of Unionmelt, Doctor, sells for about five cent a pound, does it not? Aren't you familiar with that?

A. No, I am not.

Q. Well, if you accept the statement that the Lincoln flux sells for ten cents a pound, is it not important to a
669 commercial manufacturer to use as little flux as is necessary, as a matter of cost of welding?

A. Well, again, that leaves me uncertain as to what you mean, as much as necessary.

Q. To produce sound welds without any danger of getting a poor one.

A. I would say if all the unused flux is recovered, as it commonly is, there would be no disadvantage in that respect.

Q. You assume that all the unused flux is recovered, in your answer, do you not?

A. That was my statement.

Q. Doctor, you are familiar, are you not, with suc-

tion devices following welding machines which pick up the unused flux and put it back in the hopper?

A. I don't believe I have seen any that put it back in the hopper.

Q. At least pick it up?

A. Yes, I have seen them.

Q. Those are used, in some instances and not in others, in different plants, is that correct?

670 A. I believe so.

Q. If you have a large pipe, cylindrical shaped pipe, and you are welding on top of it, and you have no suction device to pick up your flux and that flux is scraped off, comes down onto the plant floor, would you say that all that flux on the plant floor is picked up and saved and used again, in commercial practice?

A. If it is a large pipe at the top, and rather flat and wide, I don't see how it could fall down.

Q. Suppose it was just brushed off by the operator.

A. It can be wasted. There is no question about that.

Q. Doctor, when did you first become associated with this case?

A. I believe it was in May of 1946. I am not certain. It was within a month of that either way.

Q. The one demonstration; the last one we saw this morning, you will recall was a weld made through three types of fluxes.

A. That is right.

Q. First the Unionmelt, then the Lincoln and then the clay flux.

A. That is right.

671 Q. During the entire passage of the electrode the length of that welding zone, that seam, the same plate was being welded, is that correct?

A. It was.

Q. The same type rod was being used; that is correct, is it not?

A. Yes.

Q. The same automatic welding head was being used?

A. Yes.

Q. The same current and the same voltage throughout?

A. I believe so, approximately.

Q. So that the only step that anyone could see that was different was the use of a different flux; that is correct, is it not?

A. The external—

Q. Externally.

A. The external manipulations would appear to an observer to be the same.

Q. I assume they were intended to be the same, weren't they, Doctor?

A. The purpose of the test was to make it strictly comparative.

Q. Now, as to the differences in the fluxes, the Unionmelt was a grayish color; that is correct?

672 A. That is correct.

Q. The Lincolnweld was black?

A. Yes.

Q. The clay flux was a very light tan, was it not?

A. I would not quibble about the colors.

Q. Well, it was not gray and it was not black. I mean, in general terms.

A. I would have called the clay flux gray, but I do not want to argue about it.

Q. A little different gray from the Unionmelt, however?

A. Yes.

Q. With respect to the particle size of the Unionmelt, its feeling was granular, was it not?

A. I did not feel it.

Q. Will you feel it? I hand you Plaintiff's Exhibit 133-A. Feel it between your fingers, Doctor.

Particles are discernible by feel as to size, are they not?

A. They are.

Q. The clay flux, on the other hand, handing you Plaintiff's Exhibit 138, is powdered in form, is it not?

A. I should say the particle size was much finer.

Q. One, the Unionmelt, will pour steadily, will it not, and the other will not, the clay flux will not pour as easily?

673 A. Without your specifying conditions of pouring I am inclined not to quibble about the matter.

Q. You can pour them right out of the bottle onto a piece of paper. One pours more easily than the other, is that correct?

A. I would say so.

674 Q. And the one that pours the more easily is the Unionmelt; that is correct, is it not?

A. Yes.

Q. And that is due primarily to the size of the particles, is it not?

A. I would not like to speculate on that.

Q. Do you know the moisture content of the clay flux?

A. I made tests with clay fluxes, dried at quite a range of temperatures, but I cannot tell you what the moisture content of this one is at this time.

Q. So far as you know, they had not been heated up to any temperature to completely drive off the moisture, just prior to this demonstration, had it?

A. I think that it was heated, to dry it—

Q. Just prior to this demonstration today?

A. (Continuing) —and then kept in a tight can.

Q. When was it last heated, to your knowledge, Doctor?

A. It was heated at the time it was made, and it has been kept in a tight can ever since that time.

Q. Do you know—pardon me.

A. I believe it was made—

Mr. Cahill: Let the witness finish his answer, please, counsel.

Mr. Stewart: Yes. He is going to answer.

675 A. (Continuing) I believe that it was made in October.

By Mr. Stewart:

Q. Do you know to what temperature it was heated?

A. I am sure it was above the boiling point of water, 105 edgrees centigrade; that was the minimum temperature of heating.

Q. But that is not sufficient to drive off the water of crystallization, is it, Doctor?

A. I do not know that there is any water of crystallization in it.

Q. You do not know whether there was any in there, or not.

A. I do not.

Q. All right. Moisture in coated electrode fluxes is an undesirable thing, is it not, Doctor?

676 A. Not always.

Q. Not always?

A. No, sir.

Q. Moisture in clay flux, as we saw it being used there, when heated by the heat of the arc, would boceme vaporized instantly, would it not?

A. The flux close to the arc would lose some moisture, yes, sir.

Q. And the expansion of the moisture from its then

condition to a vaporous state would have an explosive effect, would it not—would expand in volume?

A. It certainly would.

Q. Now, Doctor, in bare rod electric arc-welding you have no coating on the rod; that is the distinction between coated electric arc-welding and the bare rod electric arc-welding, isn't it?

A. If in the bare rod you exclude the coating placed there in drawing the wire, your statement is right.

Q. In this chart that you talked about yesterday, marked Plaintiff's Exhibit 173, bare electrode arc-welding, what did you mean by the bare electrode in that?

A. No coating added for the purpose of welding.

Q. All right. There is no question in your mind that
677 there is an arc, an electric arc, employed when that type of electrode is used in electric welding, electric arc-welding, with no flux?

A. Since we shouldn't use the term too loosely, I would qualify it by saying free gaseous arc.

Q. Now, in electric arc-welding, Doctor, the arc is a gaseous conductor of electricity, is it not?

A. The arc is a discharge of electricity through gas. I don't quite like to say the arc is a conductor.

Q. Doctor, you were one of the authors of an article entitled "Fundamentals of Arc-Welding", published in the 1942 Welding Handbook which is put out by the American Welding Society, in which, on page 139, you said, "In arc-welding, the arc is a gaseous conductor of electricity," did you not?

A. You mean to say that is in the chapter, I presume.

Q. Yes.

A. (Continued) Not that I wrote that part. There were a number of members of the Committee.

Q. You didn't write that part?

A. I believe not.

Q. Do you know whether this was the article for which you got the Lincoln gold medal?

A. Yes, I know it was not.

678 Q. In plain language, however, Doctor, is it not true that in electric arc welding the arc is a gaseous conductor of electricity?

A. The medium through which the current flows is the conductor. The arc is the discharge itself.

679 Q. And in that medium you have an ionized gas

eous medium—or rather, that medium is an ionized gas, is it not?

A. That is correct.

Q. An ionized gaseous medium through which a welding current is passing—and by "welding current" I mean of such magnitude as is used in welding—is an arc, is it not?

A. A welding arc.

Q. A welding arc. All right. That is not an arc of an unusual type; that is an arc of the usual type, is that right?

A. For welding, yes.

Q. For welding. Now, that is the same type of arc that is used in bare electrode arc-welding, is it not?

A. Yes.

Q. Now, in bare electrode arc-welding you do not have any material entering into that medium, ionized gaseous medium, except the material of the rod and the material coming from the atmosphere?

A. You include the slight drawing compound on the rod, no doubt.

Q. If there is one.

680 A. Yes.

Q. Now, with respect to a coated electrode for electric arc-welding, what is the coating for?

A. As I described it yesterday, it is for excluding, as far as possible, the oxygen and nitrogen of the air from the region of transfer of the metal.

Q. From the arc, is it not? From the arc stream which people in the welding industry refer to?

A. Including the material passing through it.

Q. The mere fact that coating is put around the electrode to create such protection from the atmosphere does not make the arc an unusual type of arc, does it?

A. It changes it radically.

Q. It is still an arc of the usual type so far as electric arc-welding is concerned, the ordinary use of the term in the trade?

A. If you wish to define the word "usual" in this instance to cover those two types, I have no objection.

Q. Well, would you say, then, that by putting the covering on you would not have the usual type of arc?

A. I would say that it changed many of the characteristics.

Q. But the current is being conducted by an ionized

681 gaseous medium, is it not?

A. Yes, it is.

Q. That is what is known as shielding arc-welding, in one sense of the word, is it not, a coated electrode that creates a protection for the gaseous medium?

A. That term has been applied principally to cellulosic coating.

Q. But that is generally known in the welding industry

A. Yes.

Q. With a coated weld rod?

A. Yes.

Q. Now, Dr. Dean, when you make a groove in a plate, like we saw today, for the purpose of making a butt weld of the two edges of the plate, you sometimes leave what is known as a nose down at the bottom of the groove, do you not?

A. Yes.

Q. And that nose means that the groove has not gone clear to the bottom of the plate, but there is some of the plate that is butted up against—or, some of the plates that are butted up against each other, and not separated by the groove.

A. Yes.

682 Q. What is the purpose of that nose?

A. The principal purpose of it is to avoid melting through too easily.

Q. And if you melt through too easily, do you frequently get porosity, with a copper backing beneath?

A. Well, I do not associate melting through with porosity.

683 Q. Now, Doctor, as a matter of terminology, yesterday you used the terms "vapor", "mist", and I believe "liquid".

So that we may understand each other, a vapor is a gas, is it not?

A. A more accurate definition of a vapor is that it is a gas in contact with its own liquid or solid.

Q. A gas in contact with its own liquid or solid?

A. Yes.

Q. Is there a vapor in an open arc?

A. There is some vapor in an open arc, yes, sir.

Q. Mist is not vapor, is it?

A. That is correct.

Q. Would an accurate illustration be that of a tea kettle on the stove, where you have water in the kettle, which is liquid, and you have steam coming out of the kettle, which

is both vapor and mist, the vapor being right by the spout, where you cannot see it, because it is transparent, and the mist being out farther, where it appears as steam? Is
684 that an accurate analogy?

A. If you add that there is vapor with mist, farther out, uncondensed vapor—

Q. Right.

A. —yes.

Q. Now, staying with the illustration of the stove for just a moment, Doctor? If you have a pot, or a kettle of oatmeal, or corn mush on the stove, and you put the fire on underneath it, to the point where it boils, you have large bubbles coming up slowly and breaking at the surface, do you not?

A. Yes.

Q. And that is because some of the material in there has become vaporous; is that not correct?

A. Yes.

Q. It has been heated up to its vaporization point?

A. Yes.

Q. And therefore goes into a vaporous or gaseous state; is that correct?

A. Yes, sir.

Q. So that,, in those colored pictures which we saw yesterday, where the surface of the melt was turbulent, and bubbles were coming up and breaking out, that showed
685 to you, did it not, that a vapor had formed underneath and was coming out in the form of a bubble, or gas. Is that not correct?

A. Yes, sir, I would say that that is correct.

Q. That would mean to you, would it not, Dr. Doan, that the heat somewhere down in that melt had reached a point higher than the vaporization point of the flux? That is correct, is it not?

A. I should say so, yes, sir.

Q. What is the heat of an electric arc?

A. I presume you mean, what is the temperature?

Q. I do mean the temperature, yes, sir. I am sorry.

A. The latest determination, and the one which I trust most at the present time, is by C. G. Suits, who is now Director of Research of the General Electric Company.

His measurements lead him to conclude that the temperature is very close to 6,000 degrees Centigrade.

Q. That is correct, and that appeared also in an article

in the Welding Journal of which you were a co-author in 1942, did it not?

A. I am not sure.

Q. Entitled "Physics of Welding", at page 17?

686 A. (No answer.)

Q. 6,000 degrees Centigrade is twice the temperature of the vaporization point of steel, approximately, is it not?

A. Yes, sir—a little more.

687 Q. Do you know the vaporization point of Unionmelt?

A. No, I don't.

Q. It is less than steel, is it not, less than that of steel?

A. Oh, I don't know that. I don't want to speculate.

Q. You don't know and you wouldn't speculate?

A. No.

Q. All right, Doctor, referring to Plaintiff's Exhibit 167, which only contains the various drawings of the—it says the "Jones et al patent". In connection with that, I believe you testified that this region down in here adjacent to the of the electrode, which has the sort of circular lines in it, represented both molten flux and some flux in a vaporous state, did you not?

A. I did.

Q. And I believe you testified that electric current in either a liquid or a gas is transmitted by ionic mobility?

A. By ion carriers.

Q. By ion carriers. The amount of current of a substance—the amount of current that a substance would carry would be its conductivity, would it not, so long as it is in a state of conductivity? I am only trying to get a

688 relative term, that is all.

The Witness: I will have to answer the question carefully.

The Court: Read it.

(Question read.)

The Witness: Assuming that the voltage applied is the same in both cases, and the length of the conductivity path is the same in both cases, and the cross section is the same in both cases, the amount of current would be the measure of conductivity.

By Mr. Stewart:

Q. And some things are more conductive than others, in a molten state or in a solid state?

A. That is right. There is a difference.

Q. Great differences; but it is, I believe you said, the ionic mobility that determines the degree of conductivity, did you not?

A. If you assume that the same number of carriers is present, then the mobility will determine the conductivity.

Q. Well, let's keep it in that melt itself, and not having any other variables. All I am asking you, Doctor, is to summarize some of your testimony yesterday. You said
689 that some of the current was carried by the molten metal and some by the vaporous melt; did you not?

A. Yes.

Q. And you said that whether the ions can get through what is in front of them or not, their mobility has a great effect on how much current is carried, isn't that correct?

A. Other things being equal.

Q. If your flux was just barely molten so that it wouldn't even pour, you wouldn't have very much mobility of the ions, would you, relative mobility?

A. It would be decreased, compared with the fluid condition.

Q. If it is fluid, you would have increased mobility of the ions and more conductivity?

A. That is right.

Q. But if it were in a vaporous state, you would have greatly increased mobility of the ions, would you not?

A. I would expect so.

Q. And when you have the mobility of the ions through a gas carrying a current, you have the exact same phenomena as occurs in the electric arc, do you not?

690 A. Transfer of electricity by ions is characteristic of a whole range of electrical discharges, including the glow discharge.

Q. In welding?

The Witness: Will you repeat the question?

The Court: Read the question, please.

(Question read.)

Mr. Stewart: May I amend that to include "as used in welding".

The Witness: I don't know whether I will have to write that down or not. It is phrased a little bit awkwardly, and I am not sure what the meaning is.

Mr. Stewart: Doctor, I am not fencing with you.

The Witness: I want to be careful.

Mr. Stewart: That is obvious.

The Court: Read it again.

(Question re-read.)

The Witness: That is too unqualified a statement. That is saying that whenever—in my opinion, it says whenever you have the flow of current by means of ions, through
691 a gas, you have a welding arc, which is not what I think Mr. Stewart meant to say.

692 Q. Well, in a welding arc you have the flow of electricity through the ions in a gaseous medium. That is all I am getting at. If you have ions in a vapor, ionization in a vapor—

A. I do not want to quibble about this any more than you do, but I do not want to make a false statement and then have it held against me. You do not talk about electricity flowing through ions.

Q. Well, being conducted by ions, carried by ions. In other words, if your medium is in a vaporous or gaseous state and you do have the current passing through that medium at welding voltages and amperages, you have an arc, do you not?

A. I think it is fair to say yes.

Q. Now, current wants to take the path that is easiest for it, does it not?

A. That is a fair statement.

Q. And the path that is easiest for it is the most conductive path?

A. I think that is saying the same thing.

Q. In other words, if it has a choice of two paths it will take the most conductive path?

A. Not exclusively.

Q. Some might go through the other path?

693 A. A division in proportion to the resistance.

Q. If this path (indicating) is very conductive and this path (indicating) is not so conductive, but highly resistant, the greater proportion will go through this path (indicating)?

A. That is correct.

Q. Let us take the current down through this electrode. The electrode itself being made out of steel is considerably more conductive than anything else in the same area, is it not?

A. Well, I do not think we have to make that supposition for your argument. Let's go ahead without that.

Q. Well, that current has been coming down through this rod—

A. That is correct.

Q. —without melting the rod.

A. That is correct.

Q. So that the rod conducts the current without generating enough heat to melt it.

A. That is correct.

Q. Where it gets down here just to the level of what is marked "Granulated Melt" just to the bottom level of that, not clear to the bottom of the rod, the current has
694 two choices if it is going clear to the bottom; one is to continue through the rod and the other is to go out into the melt. It has those two choices?

A. At the point where the rod is immersed in the melt.

Q. Which medium, the rod or the melt, is the most conducive?

A. At that point, Mr. Stewart, the current will come out from the sides of the rod as well as the bottom and follow, as you have said, the path of least resistance.

Q. I believe you indicated down here underneath the end of the electrode is the core of this molten pool, and the core is in a vaporous state, is it not?

A. I believe that is correct.

Q. The vaporous state, vaporous condition is more conductive than the molten condition, is it not?

A. I have wanted in the worst kind of way to measure the amount of conductivity through the pool itself and the amount through the core. I have tried two very promising methods, but I have no results, unfortunately, to give
695 Q. Well, all we can do is follow your own theory of yesterday.

A. Well, let us not speculate about it.

Q. As to what you said as to which was the most conductive, the core which is vaporous, or the molten area.

A. Yes, but the larger area of the molten pool in contact with the sides of the rod may carry more current than the smaller tip of the rod in contact with the core of the pool, so I do not like to make a statement that might be very wrong about how much current flows through the core and how much flows through the pool proper.

Q. I am not asking you how much, Doctor. I have not asked you that question at all. I am only asking you the question that relatively, as between the two substances in

their different state, the path in the vaporous state for the same area—

A. Right.

Q. —is more conductive—

A. That is correct.

Q. —than the substance in the molten state?

A. In other words, the unit conductivity is higher in the vaporous state than in the liquid.

696 Q. And that is because in the vaporous state the ionic mobility is so much higher?

A. That is correct.

697 Q. And the current follows the most conductive path as a general rule, does it not, Doctor?

A. Yes, but when you come back to here, you cannot apply that general rule without realizing that the area is greater in contact with the liquid, than in contact with the vapor—

Q. Now, you did state—

Mr. Cahill: Just a moment, please. Had you finished your answer, Doctor?

The Witness: (Continuing) So that, although the unit conductivity may be higher in the vapor, the total conductivity may be higher through the melt.

By Mr. Stewart:

Q. The passage of the current generates heat, does it not?

A. Yes.

Q. And you said that there was, I believe, 100 per cent efficiency in converting electricity, the current, to heat?

A. Yes.

Q. So that if that vaporous condition in there can be called an arc, that would be generating heat, because of the very high temperature—pardon me. I would 698 like to withdraw that question.

The arc, as measured by Suits, has a temperature of, possibly as high as 10,000 degrees Fahrenheit, or 6,000 degrees Centigrade?

A. Let us say, 6,000 Centigrade.

Q. So that you have that type of heat being generated down here, or that magnitude of heat, have you not?

A. Do you mean, intenstiy?

Q. That intensity of heat?

A. Yes.

Q. Terrific heat.

A. (No answer.)

Q. You said you were surprised yesterday to learn that 100 horsepower could be generated in one cubic inch.

The only other place that you know of where that happens isby the use of an electric arc, is it not, Doctor?

A. I would not like to make a general statement of that sort.

Q. Do you know of any other place?

A. Well, into my mind comes atomic energy, and so forth, and so on, and we do not want to go into that.

Q. Let us leave that out.

A. Yes.

699 I would not want to make any general statement like that.

Q. But the same amount is generated in the electric arc, is it not?

A. The same as what?

Q. The same quantity of horsepower.

A. The same as what?

Q. The same as is generated right in there, with the arc in it.

A. I am very sorry, but I do not believe I understand the question.

Q. You said you were surprised to learn that 100 horsepower could be generated in such a small space as a cubic inch, which you believe occurs there, in that process; is that right?

A. I said "released", I believe.

Q. Released.

A. Yes.

Q. "Dissipated" I believe was the word you used, as a matter of fact.

A. Was that the word I used?

700 Q. Doctor, leaving out atomic fission, you are not surprised, are you, by the generation, or the dissipation of that amount of horsepower in that space in an electric furnace, for example, an electric arc furnace?

A. I am not sure that the unit intensity of energy released in an electric furnace, is anywhere near as high as this.

Q. You are not?

A. No, sir.

Q. But the same type of operation, the same general type of operation does take place, does it not?

A. Oh, well, there are many similarities. In an arc furnace, there is an arc.

Q. Well, let's take an electric arc furnace. In that
701 you have some sort of container, a very large container, or a very thick container, that will not melt, and at the bottom you place pig iron, or scrap iron, or whatever you want to melt, and then you have a very large arc, in diameter, that is,—or electrode, rather, coming down to that metal. Then you put slag in on top of that, do you not?

A. Well, I am not an authority on the electric furnace.

Q. You draw an arc between the electrode and that metal, do you not? And the metal melts, and the slag melts, and the slag floats on top in the electric arc furnace, does it not?

A. Those things happen in electric arc furnaces, yes, sir.

Q. The arc there, however, is melting the metal, and those go up to as high as 100 tons being melted at once, by the arc, do they not?

That is correct, is it not?

A. I thought that the point that you were making was that the concentration of energy here was very high, and not the total quantity of energy.

Q. Concentration; that is all right.

A. I am not sure the concentration of energy in an
702 electric furnace is anywhere near as high as this. 100 horsepower is a tremendous quantity.

Q. When you used that two-inch plate that you made a weld in that you drained—

A. Yes.

Q. I am referring to Plaintiff's Exhibit No. 168. In that, Doctor, I believe you testified that the minute this hole burned through you shut off the power?

A. Instantly.

Q. As a matter of fact, you said the minute the first spark appeared?

A. That is right.

Q. That spark was a blue spark, was it not?

A. No, it wasn't. It was a drip of metal.

Q. A drip of metal. Didn't an arc burn through there?

A. I didn't see it.

Q. You didn't see it; and when that did melt through there, the molten metal ran out first, did it not?

703 A. Well, I don't know which ran out first. A lot

of molten metal ran out, and a good deal of welding composition.

Q. You didn't save that, retain that metal in anything?

A. We carried it up and measured its volume, and then we measured the volume of this crater, and we found some very interesting things.

Mr. Stewart: That is one thing I am not going to ask you, Doctor.

By Mr. Stewart:

Q. Now, Doctor, I believe you said that you were not familiar with this clay flux process before you entered this suit.

A. That is correct.

Q. You are not a patent expert?

A. No, sir, I am not.

Q. Your references to prior processes or, if you have used the term, prior art, are confined to your own knowledge and not from reading of patents?

A. It means welding as I have known it.

Q. You were never in the National Tube Company, Christy Park Plant in 1930 or 1931, were you?

A. Nor at any other time.

705 By Mr. Stewart:

Q. Dr. Doan, it is your belief, is it not, that the entire space of the welding zone as indicated in that diagram is not occupied by molten welding composition because part of it is in a vaporous state?

A. That is my belief.

Q. So that the record may be clear, I was indicating, and I believe you agree with me, Doctor, the diagram, Plaintiff's Exhibit 167.

A. Yes. That is right.

Q. Doctor, you said you had not been to the Christie Park plant of the National Tube Company?

A. That is right.

Q. So you are, from first hand knowledge, wholly unfamiliar with the welding process that was employed there? From firsthand knowledge.

A. I have seen some of the welds made there.

706 Q. Have you seen some of the welds made?

A. Yes.

Q. Since this suit began?

A. Yes.

Q. The manner in which they were done or the flux composition or any other fact about that production there is known to you only by what someone told you?

A. I think there was a descriptive article published in Iron Age—

Q. In 1931?

A. —describing it.

Q. You have read that article, have you not?

A. I have seen it.

Q. You are now aware, are you not, that approximately a thousand miles of pipe was welded—

A. Some considerable figure.

Q. —in that plant?

A. I do not know what the figure is.

Q. And it is still in use today?

Mr. Cahill: Is this asking for personal knowledge, if your Honor please? Or is that question based on hearsay?

The Witness: I do not know.

707 Mr. Cahill: May I inquire if counsel is inquiring for personal knowledge?

Mr. Stewart: I am asking if he has been told since.

Mr. Cahill: If it is hearsay, I object to it and move to strike it out.

The Court: You may ask a preliminary question in order to pose the question as to whether it is hearsay or not, Mr. Cahill.

Mr. Cahill: Do you know of your own knowledge, Doctor, whether there is any thousand miles of pipe extant, welded in accordance with the processes followed at Christie Park?

The Witness: I do not.

The Court: Now, do you insist on your question, Mr. Stewart?

Mr. Stewart: I will withdraw the question, if the Court please.

The Court: Proceed.

By Mr. Stewart:

Q. You have no personal knowledge of the welding process or the operations of the Western Pipe & Steel in 1932, do you?

A. I don't believe so.

Q. Your entire knowledge of what you have desig-
708 nated on Plaintiff's Exhibit 173 as "welding as practiced by Western Pipe & Steel Co. (sometimes des-

ignated 'smothered arc' or 'submerged arc' welding"). your entire knowledge of that is based upon what you have been told or what you have read, is that correct?

A. I have conducted a great many experiments in the last six months with that process.

Q. But where did you learn about that process?

A. From the sources that I have mentioned, and from the Robinoff patent.

Q. What sources did you mention?

A. Well, from experiments principally; from the Iron Age article; from the Robinoff patent—

Q. The Robinoff patent.

A. —and from discussion with some people who are interested in that patent.

Q. You mean people connected with this suit?

A. Not only those.

Q. Doctor, in the clay flux process, in the operation of it, in your experiments with it, did you take any colored motion pictures down in the welding zone?

A. I think we did.

Q. They have not yet been admitted in evidence or offered in evidence?

709 A. I am not sure. I don't think they have been.

Q. You did take such pictures?

A. Yes, we did.

Q. You testified yesterday that you put a wire down into the molten flux while the welding operation was going on, and you withdrew it a film of flux clung to it, or streamer, is that correct?

A. That is correct.

Q. You said you did not put the wire down under the end of the electrode.

A. That is right.

Q. It would have melted, wouldn't it, because of the heat of the arc, would it not?

A. I think it would have melted.

Q. It didn't melt when you just put it in the molten flux, did it?

A. No.

Q. So that the temperature of the molten flux was not sufficient to melt the wire, was it?

A. At that point.

Q. When you have a generation of heat such as exists in the vaporous part of that pool in the arc, there is suffici-

ent heat, is there not, to melt everything immediately
710 adjacent to it, flux, steel? Those are the only two things there. You do have sufficient heat radiated by that arc, do you not?

A. In its immediate vicinity and the immediate vicinity of the core of the pool, both flux and steel melt. Farther away they don't.

Q. The normal operaton of arc-welding is for the arc stream to melt the plate, is it not? The heat generated by the arc melts the plate, does it not?

A. I don't want to quibble, but it is really the anode fall and cathode fall that does most of the melting.

Q. The melting occurs by reason of the intense heat, does it not?

A. Yes.

Q. And the penetration of an arc in open arc-welding can be controlled, can it not?

A. It can be influenced within considerable limits.

711 Q. Voltage is one means of effecting penetration, is it not,—variation in voltage?

A. The variation in voltage accompanies variation in arc length, but it is principally the variation in arc length that affects the penetration.

Q. What is the known range of voltage for electric arc? It is somewhere between what; 14 and 50, as used in arc-welding?

A. Well, generally, that is a fair range.

Q. Generally, would that be the case?

A. Generally, that is a fair range to state. I would not say that there was not anything outside of it, on either side, however.

Q. If you get below the minimum, you cannot maintain an arc, can you, and the minimum may be a volt or two below 15?

A. In speaking of open arc-welding?

Q. Yes.

A. There is a lower limit, but it is somewhere near there.

Q. Around 11 or 12?

A. Well, I do not know.

Q. And if you reduce that voltage during the welding process down below that limit, you will extinguish
712 the arc because it cannot be maintained without a minimum voltage; that is correct, is it not?

A. In the open arc?

Q. Yes.

A. Yes, sir.

Q. And when that happens, your electrode freezes to the plate; that is the welding term, is it not?

A. Yes, sir.

Q. Have you ever reduced the voltage in the Unionmelt process down below the minimum arc voltage, and found the electrode freezing to the plate?

A. Well, you cannot see what is going on down under that, and therefore it is not so easy to make statements of that kind, and be sure about them.

Q. But you can see if you take the flux away; you can look, and see the electrode frozen, can you not?

A. Yes, but those are not our conditions.

Q. Pardon me?

A. I am trying to answer your question fairly, now, but that is not a fair question. I mean, I would be unwise—or, it would not be right to answer that question.

I know what you are getting at, and I am going to agree with you when you phrase it so that I
713 am safe in answering it positively.

Q. All right. When you reduce your voltage down below that which is necessary to maintain an arc, you get the effect of what is known as the electrode freezing to the plate, where it no longer melts, do you not?

A. In open arc-welding, you do.

Q. And you can have the same thing in this case, can you not?

A. That is a speculation for me.

Q. Do you know whether or not you can have the same thing in this?

A. No, I do not.

Q. Doctor, in the demonstration which we had this morning, it was obvious to you, was it not, that the clay flux did not fall back in over the welding zone after the electrode had passed?

A. If you will add "as much as the other two." I will answer that "Yes."

Q. As much as the other two.

A. Yes.

Q. As a matter of fact, you could look down there on the molten flux, or the red hot flux there, could you not?

714 A. Yes.

Q. And you could not in the others.

A. That is correct.

Q. So that, during the welding operation, the clay was not closing in as much as it was in the others, was it?

A. That is correct.

Q. Did you ever weld with just plain sand as a flux?

A. Yes.

Q. You can enclose the arc in the same manner—well, pardon me; I will withdraw that, or else I am afraid we will get into an argument.

A. All right, sir.

Q. You do not see anything happening underneath that sand, if you use sand in place of Unionmelt, under the same operating conditions, do you?

A. Let me hear that question again, please.

The Court: Read it.

(Question read.)

The Witness: When you say "underneath the sand", I must tell you that you cannot see underneath the sand, and that there is no sand over the joint after the rod has passed.

715 By Mr. Stewart:

Q. If we had used sand this morning at the fourth foot of the plate, it would have looked the same as the Unionmelt would have looked, would it not?

A. Oh, no.

Q. No?

A. Not at all.

Q. You say not?

A. Yes, sir.

Q. Could you see the arc, if you used sand?

A. You can.

Mr. Stewart: That is all.

The Court: Just a moment, Doctor.

The Witness: Oh, pardon me.

The Court: Do you have anything further to redirect, counsel?

Mr. Wolfe: I would like to introduce the motion pictures, which I forgot, your Honor, and which Mr. Stewart reminded me of.

The Court: Very well. I want to ask Dr. Doan one or two questions.

In bare rod welding, what kind of gas is it that the conductive medium between the electrode and the metal?

716 The witness: It is both air and iron vapor, your Honor.

The Court: Now in coated rod welding, does the coating of flux create an additional or a substitute gas, conductive gas, or does the flux create a shield around whatever gas is the conductive medium?

The Witness: It creates additional gases which participate in the electrical discharge, and also it creates a shield to keep out much of the air, although not all of it.

717 The Court: One other question. What is this so-called quiet flame that you see in the Unionmelt welding?

The Witness: I have not analyzed it, your Honor, but there are a good many reasons to believe that it is carbon monoxide burning in air, the carbon monoxide probably coming from the region just outside of the pool, and just ahead of the pool where the steel in the rod and in the plate edges is being heated, and coming from the carbon in the rod and plate material.

The Court: I think that is all I have.

Redirect Examination by Mr. Wolfe.

Q. Will you state for us, Dr. Doan, the welding conditions under which the high-speed movies on clay flux were made, that Mr. Stewart inquired about?

A. Those were made on half-inch plate, 630 amperes, 30 volts, at a speed of five inches per minute, and a one-inch burden of Western Pipe & Steel, or clay flux made October 4, 1946.

Q. You were present when those were taken, were you?

A. Yes, I was.

718 Q. And you have seen the motion picture reel projected, have you?

A. Yes, I have.

Q. What do you have to say as to whether or not it accurately depicts the operation?

A. It depicts the operation accurately.

Mr. Wolfe: I offer this reel in evidence as Plaintiff's Exhibit 192.

The Court: Is there any objection?

Mr. Stewart: No objection.

Mr. Byron: No objection.

The Court: It is admitted.

(Whereupon said reel of film was marked PLAINTIFF'S EXHIBIT 192 and admitted in evidence.)

Mr. Wolfe: May we have the projector set up so we may have this run.

I have no further questions, Doctor.

The Court: You may step down.

(Witness excused.)

The Court: Before we turn out the lights, will you tell us what this is, Counsel?

Mr. Wolfe: The high-speed movie, using the clay
719 flux under conditions which are generally comparable with those of Unionmelt and Lincolnweld, in this instance offered to show contrast with those two.

In this instance the flux burden was normal, because there was no need to cut down the thickness of the layer.

I think your Honor will be able to observe the absence of contact with the pool in this view, as compared with the others.

(The projection of the motion picture film was shown, without comment.)

Mr. Stewart: May I put one simple question, your Honor, about the picture?

The Court: Yes.

GILBERT E. DOAN, called as a witness on behalf of the plaintiff, having been previously sworn resumed the stand and testified further as follows:

Recross Examination by Mr. Stewart.

Q. Dr. Doan, the same characteristic blue light, characteristic arc, appeared in that second section as appeared in the one we had yesterday?

720 A. Certainly a blue light was evident in this one, and the blue light was evident in the other one.

Mr. Stewart: Thank you.

Mr. Wolfe: No questions.

(Witness excused.)

Mr. Cahill: May I ask Mr. Kennedy one question, your Honor, apropos of the film we just saw.

The Court: Yes.

Mr. Cahill: May I ask him where he is now?

The Court: Yes.

HARRY EDWARD KENNEDY, called as a witness on behalf of the plaintiff, having been previously sworn, resumed the stand and testified further as follows:

Direct Examination by Mr. Cahill.

721 Q. Mr. Kennedy, you just saw the film, Exhibit No. 192, which has been shown?

A. Yes.

Q. And you were at Western Pipe & Steel in 1932?

A. Yes, sir.

Q. Can you tell us whether or not the picture just shown accurately depicts and portrays what you saw at Western Pipe & Steel in 1932?

A. It does with regard to the welding operation. The mechanical setup was not the same, but the welding operation was exactly the same.

Mr. Cahill: Thank you.

Mr. Stewart: No questions.

(Witness excused.)

Mr. Wolfe: Will you please take the stand, Dr. Willard.

HOBART HURD WILLARD, called as a witness on behalf of the plaintiff, having been duly sworn, testified as follows:

Direct Examination by Mr. Wolfe.

Q. Will you give us your full name, please, Dr. Willard?

722 A. Hobart Hurd Willard.

Q. Your residence?

A. 1926 Norway Road, Ann Arbor, Michigan.

Q. What is your occupation or profession?

A. I am professor of chemistry at the University of Michigan.

Q. Have you studied the patent here in suit, and particularly those portions which have to do with the chemistry of the welding compositions described?

A. Yes, I have studied the patent in suit and particularly those portions dealing with chemistry of the welding composition.

Q. Have you also studied the file wrappers and patents of the application which matured in this patent?

A. Yes, I have studied the contents of the file wrappers and the applications which matured in the issuance of this patent.

Q. What professional training and experience have you had which would qualify you to testify as an expert as to the chemical phase of this case?

A. Since receiving my doctor's degree at Harvard in 1909, I have been continuously at the University of Michigan, teaching chemistry, and I have followed
723 the progress of this particular science.

I have charge of the department of quantitive analysis at the University. I am the author of three widely-used text books in the field of quantitative analysis—co-author, I should say perhaps, senior author; I am the author of more than one hundred scientific papers dealing with the results of research in the field of inorganic and analytical chemistry; and I was a member of the board of directors of the American Chemical Society for seven years. I am still active in the affairs of the society.

Q. Do you have anything to do with its present publications?

A. Yes. I am a member of the advisory board of one of its publications.

Q. Which one is that?

A. That is the Industrial and Engineering Chemistry Analytical Edition.

Q. Have you participated in or witnessed any welding tests in preparation for this case?

A. Yes, I have witnessed dozens of welding tests at the Niagara Falls laboratory of the Union Carbide Company.

724 Q. Now, just so we can have some prospectus, Dr. Willard, on the range of matters to be considered in this patent in reference to chemistry, will you point out for us the various items that are covered in the patent, such as matters of chemical composition, properties and preparation and so on, of the welding flux.

725 A. The disclosures of this patent are unusually complete, I think. It lists, first, five essential characteristics, or properties, which the welding composition should have. It gives a group of compounds from which selection may be made for the major ingredients. It gives details of

the preferred compositions, from this available range of selection. It gives the proportions in which these materials can be combined. It shows how to prepare the compositions. It gives examples of compositions which should prove satisfactory. It lists the desired chemical and physical properties of the composition. It lists some precautions to be observed. It gives the purposes of variations in the compositions. It indicates certain additions that can be made, and the purpose of those additions.

Q. What have you to say, Doctor, as to whether or not a chemist would find here adequate directions for the preparation of welding composition?

726 A. Yes, sir, I find the directions to be complete enough, and satisfactory, for the preparation of a number of suitable compositions.

By Mr. Wolfe:

Q. Do you have any knowledge of the chemical analyses of the welding compounds sold by the Plaintiff here under the designations Unionmelt Grade 20 and Unionmelt Grade 90?

A. Yes, sir, I have analyses of both of those compositions.

Q. Have you had any occasion to be in contact with the analytical chemists in Niagara Falls?

A. Yes, sir, I have spent a good deal of time in the laboratory of the Union Carbide Company. I am familiar with their processes. I have sometimes checked their analyses myself, and found them correct. I have been

727 for some years well acquainted with Mr. Cunningham, who is head of the Analytical Laboratory. I served on a committee with him for a time. I know that the laboratory is thoroughly reliable.

Q. Well, now, on the basis of the information so acquired, how do the chemical compositions of these Unionmelt compositions compare with that set out in the patent?

728 The Witness: They are the same as those set out in the patent, and one of them, Unionmelt 20, is practically the same, within commercial limits, as one of those, the analysis of which is given in detail in the patent.

By Mr. Wolfe:

Q. Will you state for us first of all, just in general terms, how this Unionmelt Grade 20 and Unionmelt Grade 90 should respectively be designated in chemical terms?

A. Unionmelt Grade 20 is a silicate of calcium magnesium and aluminum, with a halide salt added.

Unionmelt 90 is a silicate of calcium, manganese and aluminum, with a halide salt added.

Q. You will recall, Dr. Willard, that two bags of Lincolnweld 660 flux were furnished to us by the De-
729 fendants.

Did you take samples from each of those bags, and make chemical analyses of them?

A. Yes, sir. Those analyses were made under my direct supervision, in my own laboratory at the University of Michigan, and I can vouch for their accuracy.

Q. Again will you state for us, for the moment at least just in general terms, the chemical composition which you found in that Lincoln flux?

A. I found that it was calcium manganese silicate with a halide salt added, in this case calcium fluoride.

Q. To aid the Court in making clear the various technical matters of chemistry that will be involved here, you have, I understand, prepared an explanatory chart or demonstration board, is that right?

A. That is right. There are some terms, technical terms, that have been used up to the present time, and it seems worth while, I think, to explain those a little more in detail.

Mr. Wolfe: I have here photographic copies of this board for the convenience of the Court and counsel,
730 which I think will make it easier to follow the explanatory legends and so forth from a distance.

I will ask that the board be marked for identification as Plaintiff's Exhibit 193.

(Whereupon said board was marked Plaintiff's Exhibit 193 for identification.)

By Mr. Wolfe:

Q. Now, Doctor, referring to this Exhibit 193, will you first of all point out for us the general layout of material that you have there?

A. In the top row we have the chemical elements which are involved here. Now, all matter is made up of chemical elements or combinations of them. There are at present 96 chemical elements which are known; and by "chemical element" I mean one which cannot be chemically separated into any other constituents.

Those we are especially concerned with here are shown here. In this tube at the left of the chart in the upper row

we have the metal, calcium. The next one to the right is magnesium. Then manganese, and then aluminum. Oxygen, being a gas, is not shown here. Here we have
731 silicon.

Over here again we have calcium. Fluorine, being a gas, is not shown here. Fluorine is a very active element and it would be impossible to find a container for it that would resist its action.

With respect to those chemical elements you will notice that each one has a symbol. The symbol for calcium is Ca. The symbol for magnesium is Mg. The symbol for manganese is Mn. The symbol for aluminum is Al. The symbol for oxygen is O. The symbol for silicon is Si. The symbol for fluorine is F.

Now, these chemical elements can combine with other elements to form compounds, and we are especially concerned here with the combination of these elements with oxygen. Now, I have here—suppose we start with calcium. When calcium combines with oxygen it forms the oxide of calcium, the formula for which is CaO. That is Ca standing for calcium and O for oxygen, one atom of each one. The combination of these two atoms results in what we call a molecule of calcium oxide, a molecule, then, being a combination of two or more atoms to form a definite compound.

732 Now, we can also have molecules combining with each other to form more complex molecules so that as we shall see later, we can have these metallic oxides here combining with silica to form silicates.

You will notice that these oxides bear no resemblance whatever to the elements from which they were derived. We have calcium, a metal, as you see here, uniting with a gas, oxygen, to form the oxide of calcium, CaO, which is the formula as shown under the tube at the left in the second row, here, CaO, and this is a white powder, a very stable substance, which bears no resemblance to the calcium or to the oxygen from which it was derived.

In the same way magnesium can unite with oxygen to form the compound magnesium oxide shown in the second tube in the second row beginning at the left, which is also a white powder which bears no resemblance whatever to the metal magnesium or to the gas oxygen.

Next we have manganous oxide, MnO, formed from manganese, which is the metal in the third tube, top row from the left. This forms the oxide MnO, which is a green

powder which likewise is totally different from its
733 constituents.

Then over here we have, next to the manganeous oxide, aluminum oxide formed by the combination of aluminum with oxygen to form this white powder which we call aluminum oxide, and the formula is Al_2O_3 indicating that for every two atoms of aluminum there are three atoms of oxygen. Why this difference in proportion I will explain a little later.

Here we have the metal silicon, or element, which combines with oxygen to form the oxide of silicon, SiO_2 which is a white powder. It occurs naturally and is familiar to everyone in the form of sand.

It is also possible for the element calcium to combine with fluorine to form calcium fluoride, CaF_2. This also goes under the name of fluor-spar and fluorite when it is found in nature. The sample that is in this tube on the right in the second row is the natural mineral fluorspar which occurs very frequently in beautifully crystalline form, and this is a specimen which was broken off from a crystal of the natural occurring mineral.

Now, this process of uniting with oxygen is termed oxi-
dation. That term came up I think yesterday, and I
734 think your Honor inquired about the meaning of it.

Now, oxidation, I think, deserves perhaps a little more discussion. Suppose we start with a very simple subject, hydrogen, and we combine that with oxygen. One atom of hydrogen combines with two atoms of oxygen to form one molecule of water, *the formula of which* is H_2O. —I beg pardon. Two atoms of hydrogen combine with one atom of oxygen to form water, which has the formula H_2O. That is the oxidization of hydrogen.

Whenever we burn carbon, as in a coal fire or a furnace, the carbon in the fuel is combining with oxygen to form the gas carbon dioxide, which is commonly used as a constituent of carbonated beverages. This carbon dioxide represents a common oxide of carbon.

Carbon can also form another oxide in which one part carbon combines with one of oxygen to form carbon monoxide. Carbon monoxide is well known as being a poisonous gas which has caused many deaths from the exhausts of automobiles; and it has also been mentioned as the possible constituent of the blue flame which appeared in the welding process.

735 Carbon monoxide is a combustible gas, because it can be oxidized still further. It has taken up only one atom of oxygen.

Now, carbon dioxide contains two atoms of oxygen; therefore when carbon monoxide burns, it taken up one more atom of oxygen and forms carbon dioxide, and this carbon dioxide cannot take up any more oxygen.

Now, the question of why we get different proportions here. The combining power of an element is defined by what we call its valence. If we start with hydrogen, which has a valence of 1, and with oxygen which has a valence of 2, that means that oxygen with a valence of 2 can combine with two atoms of hydrogen, with a valence of 1, to form water.

Now, some elements have more than one valence; some only one.

In the calcium, we have a valence of 2. Since oxygen has a valence of 2 and calcium has a valence of 2, they will combine in equal portions, one calcium atom and one oxygen atom, to form CaO.

736 The same is true of magnesium. That has a valence of 2.

When we come to manganese, we have an element which exists in more than one valence. Manganese can have a valence as high as 7, and the properties of this element and its various valences are entirely different from each other.

For example, the oxide Mn_2O_7 is a purple liquid and an explosive material, unstable; whereas the oxide MnO, which you see here, is perfectly stable. In one case manganese has a valence of 7; in the other, the valence is 2. Very different.

Manganese can also form oxides of still other formulas. They have formulas Mn_2O_3, Mn_3O_4, and MnO_2.

MnO_2, unlike MnO is black, and occurs in nature in the form of a mineral.

Aluminum has a valence of 3; therefore one atom of aluminum can unite with any element in equal proportions, with anything that also had a valence of 3.

But oxygen, you see, has a valence of 2; therefore in order to write the proper formula here, we must take two atoms of aluminum, which would give total valence
737 of 6, and combine with three atoms of oxygen, which would give total valence of 6, to balance. That is why the formula for aluminum is Al_2O_3, and not quite as simple

as these, because aluminium has a valence of 3 instead of 2, as in the other case.

Now, when we come to silicon, silicon has a valence of 4. Therefore one atom of silicon can react with two atoms of oxygen to form SiO_2, which is ordinarily called silica.

Fluorine has a valence of 1, and calcium, with a valence of 2, result in a combination then of one calcium reacting with two atoms of fluorine to form calcium fluoride.

Now, as I have already pointed out, if we started with these elements here, we would have to combine them first with oxygen. We could not form a welding composition by melting together these—by starting with the elements in the elemental form. You can't do that. They have to first be combined with oxygen to form oxygen combining compounds.

As I pointed out before, molecules can combine with each other to form other molecules.

738 Now, one type of combination is the combination of acids and bases to form salt. An acid is a compound which contains hydrogen, which can be replaced by a metal, and a base is a compound which contains the group OH, which we call hydroxyl.

739 Now, acids show certain definite properties. They have a sour taste, and they turn litmus paper red; litmus being the extract of a plant which has the property of being red in an acid medium, and blue in an alkaline medium, or basic medium.

The hydroxyl group, then, is characteristic of the bases.

Now if an acid contains oxygen, and we take away the hydrogen from it by subtracting water, we have left an oxide, which may have acidic properties, and the same way with a basic material.

If we start with a hydroxide, containing the OH group, and we take away from that water, H_2O, we have left then a compound containing no hydrogen, and no hydroxyl, but an oxide.

These oxides will have similar properties to the bases from which they were derived.

Now take calcium, for example. If we add calcium oxide to water, that is the process which we ordinarily refer to as the slaking of lime, and as you know, it generates considerable heat; it has quite a violent reaction.

In that process the calcium oxide reacts with water to form the hydroxide $Ca(OH)_2$, with two molecules
740 of OH, two of those groups.

And conversely, if we start with a hydroxide, and heat it to give off water, we will have the oxide left.

So when I am speaking of acids and bases, or acidic substances and basic substances, I do not have reference necessarily to the acid itself, but to the oxide from which the acid is derived, and which will have similar properties.

Now, in the case of these substances here, calcium, magnesium, manganese and aluminum, they are basic substances; those oxides are basic.

Aluminum, however, can also show acidic properties, and basic properties, in which it differs entirely from those other oxides, calcium, magnesium and manganese, which can show only basic properties, but never any acidic properties.

I am speaking now of manganese with a valence of two.

Silica, when it forms SiO_2, acts as an acidic element, and does not act as a basic element at all.

So we have here several types; we have calcium, mag-
741 nesium and manganese, basic only, with a valence of two; and aluminum can act either as an acid or a base.

In this compound that we are dealing with, it acts as a basic element.

Silica acts only as an acidic element.

Now the combination of an acid and a base, or an acidic oxide and a basic oxide, results in the formation of what we call salt.

A salt, then, will not have either acid or basic properties, because they have been neutralized by this combination of the two.

For example, if we heat calcium oxide with silica, we form a salt, which we call calcium silicate, and that is one of the compounds that we are interested in here.

The Court: I am still a little bit confused; at least, I do not as yet have very much of an understanding as to the difference between a basic element and an acid element.

The Witness: A basic metal—or a basic oxide, rather, your Honor—the metals themselves do not show the prop-
erties, but the oxide—a basic element is one which can
742 unite with an acidic element, to form a salt, the salt being neither acidic nor basic.

Let us take a simple case, for example. Suppose we take ordinary soda, with which we are all familiar, I think. Take soda, baking soda, and suppose we react that with hydrochloric acid. The resulting product will be a salt

called sodium chloride, which is known to all of us as common table salt.

Now, sodium chloride is neither acid nor basic in its properties; it is what we call a neutral salt.

That is an example, then, of the combination of an acid and a basic material, sodium carbonate here acting as a basic material, to form a neutral salt.

Now, that is the reaction which would occur in a solution.

But we take hydrochloric acid in water, which would show acidic properties, and we add sodium carbonate solution, or sodium oxide, or sodium hydroxide, which shows basic properties, and they neutralize each other to form a salt which is neither acidic nor basic.

743 Now some of these reactions do not go in aqueous solution. If we take silica, as shown here, silicon dioxide, which is an acidic constituent, and if we mix that with calcium oxide, there will be no reaction at ordinary temperatures.

It is necessary to apply a very high temperature to cause those two to combine.

If we apply the heat of an electric furnace, or a gas-fired or oil-fired furnace to a mixture of those two oxides, they will combine to form the salt, calcium silicate, and that will be a fused material.

Now, I do not know whether I have made that clear to your Honor or not. I know that this is a very complex subject for a man who is not a chemist.

The Court: I do not think the Court should make any admission about that at this time. (Laughter)

The Witness: Well, I hope that you will feel perfectly free, your Honor, to ask me any questions that occur to you, because my sole purpose here is to try to make this just as clear as I can.

744 Now, these oxides, when combined with silica,—that is, these basic oxides, calcium, magnesium, manganese and aluminum, when combined with silica to form silicates, as I said—this has to be carried out at a high temperature, but it does not necessarily have to be in an electric furnace, as indicated here. It can be in an electric furnace, or it can be done in a gas or an oil fired furnace.

The whole idea here is to get a high temperature, and any way of accomplishing that would be perfectly satisfactory.

The pictures shown here indicate the electric furnace, but I do not want that to convey the impression that it has to be done necessarily in an electric furnace.

745 Now, these are melted together, as the patent says, and a halide salt is added. They recommend calcium fluoride for that. Perhaps I had better deviate here for a moment and explain what is meant by a halide salt.

There are four chemical elements which are called halogens. They are fluorine, chlorine, bromine and iodine. That term "halogens" is a name that is conveniently used to refer to all of these. Now, the one that we are particularly concerned with her is the first one I mentioned, fluorine. That is one of the halogens, and when that combines with calcium to form the salt, calcium fluoride, then we have the fluoride salt which is referred to in the patent under the name of fluorite or fluorspar when it occurs in nature. That is shown over here on the right in the second row, calcium fluoride.

These oxides then are fused with silica and then calcium fluoride is added according to the statement of the patent, and in that way we get a silicate of whatever metals were used originally, with a halide salt added, and this fused material, which has now been allowed to react until
746 the reaction is complete, is poured out onto a cold plate so it will cool quickly as directed in the patent.

This material, after it has been cooled, is then ground up and we get the material shown in the bottom row here, Unionmelt 20, Unionmelt 90, Lincoln flux 660.

Which one we get will depend entirely on what we started with. They all have one thing in common. They all contain silica as one essential ingredient. The grade 20 Unionmelt contains also calcium, magnesium and aluminum. Grade 90 contains manganese as an important constituent, and the Lincolnweld 660 contains a manganese silicate as one of the main constituents.

If we want to make Unionmelt we start out with calcium and magnesium, combine them with silica by fusion, add calcium fluoride or fluorspar, and that will give us Unionmelt 20.

If we want to get one of the other compounds, Unionmelt 90, we start with calcium and we do not use much calcium, just a very little of it in that. We use mostly manganese and aluminum and silica, with the fluoride added, and then we get grade 90.

747 If we want to make Lincolnweld 660, we start out with mostly a manganese oxide, combine that with silica, with a little aluminum and add the calcium fluoride, and then we have Lincolnweld 660.

So, the same process in general is carried out, but the ingredients are, of course, different according to the particular compound we desire to prepare.

Q. Now, Dr. Willard, let us turn back to the text of the patent for a moment. I think we might take up item by item these various features of chemical direction you told us it contains.

Will you first of all point out for us the detailed directions which you mentioned previously for preparing the particular composition or compositions for which the patentees expressed a preference?

A. Well, in the patent on page 2, beginning with line 38—no; beginning with line 62, there are listed certain compounds which have been found useful in preparing welding compositions.

Q. And that is the sentence which reads:

"We have used calcium silicate and silicates of
748 sodium, barium, iron, manganese, cobalt, magnesium, nickel and aluminum, both in binary and ternary combinations, in various proportions"?

A. That is right.

Q. All of those I see you have not included in your top line of elements here, is that right?

A. No, I have not included some of them because they are not commonly used and were not involved in this case.

Q. Are there any in the top line here of your chart that are not expressly mentioned in the patent?

A. Yes. I have not mentioned here sodium, barium—

Q. Excuse me.

A. Yes.

Q. I think you misunderstood me. I said, are there any in the top line of your chart which are not expressly included in the patent?

A. Oh, no, no. Those metals which I have shown in the top line are all expressly mentioned in the patent.

Q. Now, turning from that general classification, how about the directions for the preferred compositions, as the patentees so designated them?

A. Well, the preferred compositions, I think, are
749 given specifically on page 2 of the patent, column 2, beginning with line 1 and extending down to line 63.

Q. Well, let us start there at the top. That reads:

"More specifically, the welding composition preferably comprises, as its principal ingredients, silica (SiO_2), at

least one basic constituent consisting of an alkaline earth such as lime (CaO) or magnesia (MgO) or a mixture thereof, and alumina (Al_2O_3)."

Is that indicated here on your chart, Exhibit 193?

A. Yes. At the left here in the second row calcium oxide is shown. Next to it is magnesium oxide. Over here on the right, the fourth one in the row beginning at the left is aluminum oxide.

Q. Then they also refer to silica, SiO_2?

A. Yes. Silica, SiO_2, is shown in the fifth tube to the right in the second row.

Q. You have applied their term here "basic constituent" to the arrow line from the one oxide group here?

A. Yes. These oxides are all basic constituents and the silica is the one acidic constituent.

Q. What is meant there by "alkaline earth"?

750 A. Well, the term "alkaline earth" is an old term. In the old days, the medieval chemists used that term. They applied it to the oxides of calcium, barium and strontium, not realizing that they were oxides.

They called them earths because they used the term "earth" to indicate something that was not soluble in water. In 1808 Davy found that these were oxides of calcium, barium and strontium, so it was suggested that these metals, calcium, barium and strontium be called alkaline earth metals.

This term has been rather loosely used to indicate a variable number of substances, so that one has to look at the context in order to know just precisely what is meant.

In this case it seems to have been used in a general way to indicate basic constituents, these that I have shown here, and to include magnesium and manganese along with calcium. Strontium, however, is not included here and it will be noted that all of these oxides that are included here are the basic oxides, that they have a valence of 2, in these cases. Calcium, magnesium and manganese are basic

751 oxides.

Q. Now, following the directions of the patent for materials to be used, it then continues, reading from the text where I left off:

"The silica and basic constituents are in approximately the proportions theoretically required to form metasilicates, although a substantial excess of silica is permissible and frequently advisable. For example, if the basic con-

stituent is lime, the proportions by weight will be approximately 0.7 to 1 part of CaO to 1 part of SiO_2; and if magnesia is substituted for part or all of the lime, the silica is increased accordingly, so as to maintain about the same stoichiometric proportions."

Now, what does that direction of the patent mean, Dr. Willard?

A. To each element has been assigned a value which we call the atomic weight, and those numbers are very fundamental numbers which are absolutely indispensable in the study of chemistry.

Hydrogen has an atomic weight of 1. Oxygen has an
752 atomic weight of 16. Calcium has an atomic weight of 40. Magnesium has an atomic weight of 24.3. Manganese has an atomic weight of 54.9, roughly. Aluminum has an atomic weight of about 27, and silica of about 28.

753. Now, these atomic weights are very important, because they indicate the relative weights in which the metals combine.

I have explained previously that one atom of a metal could combine with one atom of oxygen, for example, but that doesn't tell us practically what we want to know, because we want to know how much by weight. We have to weigh the materials, so we want to know, as to one atom, how much would that mean in grams or pounds. Well, by means of these figures, which are characteristic for each element, we have a method of determining that.

Now, when I say elements combine in stoichiometric proportions, that means in the proportions indicated by their valence or in multiples of that.

The Court: What is that valence?

The Witness: Well, the valence is a very difficult thing to understand, I think. Valence is a term which is used to express the combining power of an element.

Now, when we say that oxygen has a valence of two, we mean it can combine in a one to one ratio with any
754 other element that has a valence of two. But if the other element has a valence of one, it would take two of that element which has a valence of one to combine with oxygen.

In the case of aluminum, with a valence of three, it would combine with any other element containing a valence of three, in equal proportions.

That has nothing to do with the weight; that just represents the number of atoms or molecules that combine.

For practical purposes, we are not so much interested in the number of atoms that are there. If we are going to make up a composition, we must weigh it out in pounds or grams; therefore we must know the relative proportions expressed in units which will correspond to the weight; we must weigh it out.

When we say oxygen has an atomic weight of 16, and we know hydrogen has an atomic weight of 1, if we want to form water, we know it takes two atoms of hydrogen with a valence of 1 to combine with one atom of oxygen with a
valence of 2; and if we know the atomic weight of
755 hydrogen is 1 and the atomic weight of oxygen is 16,
then we can assign to the two atoms of hydrogen an arbitrary weight of 2, and to oxygen a weight of 16.

That means if we weigh out our constituents we would weigh out two grams; for instance, of hydrogen, and combine that with 16 grams of oxygen, the result being water.

Have I made that clear?

The Court: You have to take the valence with the atomic weight and combine the two?

The Witness: Yes. The valence tells us the relative number of atoms we must combine. The atomic weight tells us the weights in which we must combine them; and of course the atomic weights are extremely important, because in practical use we must know the actual weight of the substance we weigh out.

So when we speak of a molecule of calcium oxide, for example, we know it is made up of one calcium atom with an atomic weight of 40, and one oxygen atom with an atomic weight of 16, so we say the weight of the molecule which
results in that combination, calcium oxide, has the
756 molecular weight of 56; in other words, the sum of the
atomic weights of the compound—or rather I should say the atomic weight of the element multiplied by the number of atoms in the element of the compound, and those added together will give us what we call the molecular weight.

Suppose we take an example. Suppose we wanted to make some calcium oxide, and we have some of the metallic calcium I have in the tube up there. We know it would take 40 parts—that is, for every 40 parts of calcium we started with it would take 16 parts of oxygen by weight to combine with it, to make 56 parts of calcium oxide. 40 and 16 would give us 56. 40 grams of calcium would react

with 16 grams of oxygen to give us 56 grams of calcium oxide. We call this, then, the stoichiometric proportion.

The stoichiometric proportions are the proportions in which atoms or molecules combine to form compounds, and that is determined, in the case of a simple compound composed of individual atoms, we might say it is determined by the valence of the atoms.

757 Now, in the case of salts like calcium silicate, more than one ratio is possible. We can have one calcium, Ca, reacting with one of silica, SiO_2. That would give us calcium silicate; CaO plus SiO_2 would give us $CaSiO_3$. That is what we call calcium metasilicate.

Now, if we took two molecules of silica, we could also form another calcium silicate in which we would have two silicas acting with one of calcium. That would not be metasilicate, but it could still be in stoichiometric proportions.

Now, when we speak of stoichiometric proportions, we should indicate how they can be used in substituting one element for another. Suppose, for example, we wanted to substitute for the calcium oxide in Unionmelt, we wanted to substitute manganese oxide, MnO. The question is, how much manganese oxide would be equivalent to a certain amount of calcium oxide, chemically equivalent, so we could maintain one molecule of manganese oxide instead of one molecule of calcium oxide. If we maintained that ratio

758 we say those are stoichiometric proportions.

I have also explained that calcium oxide has a molecular weight of 40 plus 16, or 56. Manganese oxide has a molecular weight—the atomic weight of manganese being approximate 55 and that of oxygen 16—of 55 plus 16, or 71.

I wonder, would it be any better if I were to write these on a little piece of paper here? It is a little difficult to follow this, perhaps, without that.

Let us start with calcium oxide. Ca has an atomic weight of 40. Oxygen has an atomic weight of 16. Therefore the oxide, CaO, will have a molecular weight of 56.

These numbers represent atomic weights, 40 and 16, and the sum represents the molecular weight.

Now let us take manganese oxide, for example. Manganese has an atomic weight of approximately 55, and oxygen has an atomic weight of 15, so that the molecular

759 weight of the manganese oxide, then, would be the sum of those two, or 71.

Now, chemically, 56 parts of calcium oxide are equivalent to 71 parts of manganese oxide.

The difference is brought about by the difference in the atomic weights of the calcium and manganese, and each one of these figures represents one molecular weight expressed in grams, pounds, or any other unit you choose.

Each one of these figures represents, then, the equivalent of one molecule of the particular oxide.

One of these happens to be heavier than the other, but in combining power they are the same.

That is, if we want to form a metasilicate we would combine one of calcium oxide with one of silicon dioxide.

Now let us take silica here. Silicon is approximately 28, and we have four oxygen, now, which would be 64, each one having an atomic weight of 16, and the sum, then, would be 92, which would be the molecular weight of silica.

760 Now suppose we want to make calcium metasilicate: We must have one molecule of calcium oxide, and one molecule of silicon dioxide, and so if we start with 56 grams, or pounds, of calcium oxide, and mix that with 92 grams or pounds of silicon dioxide—or rather, wait just a moment. I see I have made a mistake here. This should be 32. I was thinking of the valence of silicon, and not the number of atoms here; so that we will have 60 here. Silicon has a valence of 4, and that is what I had in mind. Silicon

761 combined with two atoms of oxygen, which have an atomic weight of 32 there. So 56 parts of calcium oxide mixed with 60 parts of silica, and then fused together, will give us a calcium metasilicate, one molecule of calcium oxide, and one molecule of silica.

Now, suppose we wanted to make a metasilicate of manganese. Well, we start now with 71 grams, or pounds, of manganese oxide, and we combine that with the same amount of silica, which is common to both, because we want one molecule of silica to one of manganese oxide, so that we start with 71 pounds, or grams of manganese oxide, and we would combine that with 60 grams or pounds of silica, and we would have metasilicate of manganese, and we could do the same for magnesium.

We would take the atomic weight of magnesium, a little over 24, and add 16 to that, and we would have 40, for the approximate molecular weight of magnesium oxide.

If we wanted to make a magnesium metasilicate, then we

would take 40 grams or pounds of magnesium oxide
762 and combine it with 69 grams or pounds of silica, and we would have a magnesium metasilicate.

So that is what we can do by combining them in stoichiometric proportions.

Now, if you will look at the patent here, you will note that in line 10—it says, starting at line 10, on page 2, column 2:

"For example, if the basic constituent is lime, the proportions by weight will be approximately 0.7 to 1 part of CaO to 1 part of SiO_2; and if magnesia is substituted for part or all of the lime, the silica is increased accordingly, so as to maintain about the same stoichiometric proportions."

Now, let us see why that would be. Suppose we take magnesium, 24.3, and oxygen, so that we would have—40.3 would be the molecular weight of magnesium oxide.

Now, again, we want one molecule of magnesium oxide to combine with one molecule of silicon dioxide, which is 60, so we take 40 parts of magnesium oxide and 60 parts of silicon oxide.

Now, if you will look here, you will see that it says
763 that the amount of silica must be increased if magnesia is substituted for calcium oxide.

Now, if we had used calcium oxide here, we would have taken 56 parts of calcium oxide, to 60 parts of silica; in other words, almost equal weights.

However, if we start with magnesium oxide, we have got to take about 50 per cent more silica to combine with it, to get the metasilicate, than we would have to use if we had used calcium oxide, and that is why the patent indicates that the amount of silica must be increased if we use magnesium oxide, because of the lower molecular weight of the magnesium.

We have 40 parts of magnesia, and 60 parts of silica—56 parts of lime to 60 parts of silica, so that you see that the amount of silica in the case of the magnesia, has to be increased by about 50 per cent, in order to get the same kind of a silicate.

I do not know whether I have made that perfectly clear now or not, your Honor.

The Court: What do you mean by a metasilicate?

The Witness: The term metasilicate, your Honor

764 is an empirical name that is applied to the compounds containing one molecule of silica and one molecule of metal oxide—calcium, magnesium or manganese.

If we used two molecules of silica to one of metal oxide, we would have a silicate, but it would not be a metasilicate. It would be another type of silicate.

But they are all silicates, and that is simply a convenient way of saying that there is one molecule of oxide to one of silica.

766 By Mr. Wolfe:

Q. Dr. Willard, you called my attention to two or three items in the stenographic transcript of the proceedings of yesterday afternoon here, that you wanted to have corrected.

A. Yes, sir.

Q. Beginning at the bottom of page 722, and following at the top of page 723, the transcript presently reads:

". . . and I have followed the progress of science."

What correction do you desire to have made there, Doctor?

A. I meant to say, the progress of this particular science, referring to chemistry.

Q. Also on page 728, the record currently reads:

"Unionmelt 90 is a silicate of calcium, magnesium, calcium manganese and aluminum, with a halide salt added."

What correction do you desire to have made there?

A. That should read: calcium, manganese and 767 aluminum, with a halide salt added.

Q. Also on page 759, the paragraph at the bottom of the page, the transcript now reads:

"Now, let us take silica here. Silicon is approximately 28, and we have 4 of oxygen."

What correction do you desire to have made there?

That should have been: 2 of oxygen.

Q. And it continues:

". . . which would be 64."

That would reduce that, I take it?

A. Yes—which would be 32.

A. And then it continues:

". . . each one having an atomic weight of 16, and the sum, then, would be 92", it reads.

A. No, that would be 60.

Q. Now, when we recessed yesterday afternoon, Dr.

Willard, you had been explaining the directions of the patent for selecting and proportioning various ingredients for use in the welding composition.

Will you proceed with that, please.

A. As I explained before, the patent emphasizes first the use of the calcium silicate. We start out here
768 with calcium oxide. I think I explained before we cannot start out with the element calcium, but we start out with the oxide in which calcium has been combined with oxygen.

In connection with this I stated calcium had a valence of 2 and oxygen had a valence of 2; therefore they combine in equal proportions. But I think perhaps I can explain this question of valence a little bit better by using a graphic illustration.

I might say this conception of valence is one of the most difficult things our students in chemistry have, and it is rather hard to make this clear to students, and even more so, of course, to anyone who is not a chemist.

Suppose I take calcium, Ca, and, since it has a valence of 2, I will put on here two little hooks indicating that it can combine with something with those two valences.

Now, I will put on here, over here just to the right of it, oxygen, and that has a valence of two. I will put here two hooks on that.

769 Now, when these hooks unite— I will indicate that by another line here—these hooks have hooked together, and we have calcium oxide.

Now, in the case of silica—I should say silicon, rather, with a valence of 4, silicon I will put here four hooks, because it has a valence of 4. And since oxygen has a valence of 2, I will write here an O, representing oxygen, and I will put on here two hooks.

Now, in order to take care of that, in order to hook on to these other two hooks on the silicon, I must take another atom of oxygen, which also has two hooks; and when these are all hooked together, we have silica, which is SiO_2. So I think that perhaps if we look upon these valences as a sort of bond, it may give perhaps a better idea.

Now, it would be difficult to say why one element has a valence of 2 and another has a valence of 3. It is just a fact that this is a property of the element itself; and in the case of aluminum—I might take that, because it has a valence of 3.

Now, I will put three hooks on the aluminum. To form the oxide, here is an atom of oxygen that has two hooks, but there is an extra hook on the aluminum that hasn't
770 been connected, so I will have to take another atom of aluminum on which I will put three hooks, then I will take another atom of oxygen to use two of these hooks, and a third atom of oxygen to satisfy the remaining two hooks, in this way.

771 Now, connecting these up to indicate that the aluminum has combined with the oxygen, we will have the oxide of aluminum which is Al_2O_3.

Now, on the question of atomic weights, the atomic weight of calcium is 40, that of oxygen is 16, and when we join them together we have 56 for calcium oxide. In other words, 40 parts of calcium react with 16 of oxygen to give 56 parts of the oxide.

Here (indicating) we would have the same. We have 28 for silicon in this case. We would have 16 of oxygen here and 16 for this (indicating), a total of 32 for the oxygen and 28 for the silicon, and adding these two together then we would have 60 parts of silica formed from 28 parts of silicon and 32 parts of oxygen.

In the case of aluminum with an atomic weight of 27 we would have 27 for one of aluminum and 27 for the other; 16 for this oxygen (indicating) and 16 for this (indicating) and 16 for this (indicating), a total of 48 for the oxygen and a total of 54 for the aluminum. Adding these together we would have 102 parts of aluminum oxide, then, formed from 54 parts of aluminum and 48 parts of oxygen.

772 We might liken this term "atomic weight", the fact that the elements have different atomic weights—we might liken it, perhaps, to this: Suppose we take a bushel of wheat. It weighs 60 pounds. Suppose we take a bushel of oats. That will weigh less, perhaps 32 or 38 pounds. Suppose we take a bushel of feathers. That will weigh much less. So we have a bushel of different substances with different weights of material, and we might consider that as somewhat analogous, then, to illustrate how these different elements have different atomic weights.

Q. Now, returning to the different problems presented here in the patent in relation to its direction, how would we apply this material that you have explained to the formation of these various silicates?

A. We find here that there are certain basic ingredients

which are shown in the tubes in the second row at the left. There are several of those.

We have also one acidic constituent only. This simplifies the matter somewhat because we have only one acidic constituent, and then we have the calcium fluoride, the halide salt, which is added, and that is added in definite quantities in each case—the patent says one ounce to the pound
773 of flux—so we have not to consider any variation in that respect.

Silica being an ingredient in all cases, there is no variation in the material to be used there, as far as the material itself is concerned, so it reduces down to the one variable.

The variable constituent, then, will be one of the basic materials, calcium, magnesium, manganese or aluminum.

Q. Just to help make it clear what you chemists mean by "basic constituent" in such a case, will you give us some synonym or analogy?

A. The term "basic" is used, of course, with many different meanings in the ordinary language, but here it has one particular meaning only, namely, it is the same as alkaline.

That is, an alkaline substance, and a basic substance, then, which mean the same thing when we are talking about the constituent in the patent.

Now, as to the term alkali, what I mean by the term alkali might be illustrated by some common examples. When one has an acid stomach, he is told to take soda, which
774 neutralizes the acid of the stomach; and you read a great deal in these days, in advertisements, about alkalizing the system.

So when I use the term alkali, or, rather alkaline, it should be considered as meaning the same thing as basic.

Q. Pardon me, Doctor, but I believe I interrupted you there when you were telling us about the formation of these silicates.

A. Yes. These silicates, then, are reacted—or, that is, the oxide, then, will react with silica in definite proportions, as directed in the patent.

It states there, that they should form a metasilicate. That would mean that one molecule of calcium oxide may react with one molecule of manganese oxide, MnO—or, rather, I should say, with one molecule of silicon oxide, SiO_2, to form calcium silicate; and then to that calcium silicate we can add the calcium fluoride.

Now, instead of using the calcium silicate, we can start

out with one of these others; we can use magnesium oxide, and combine that with silica, in which case the proportion will be somewhat different.

775 Looking at the patent, on page 2, column 2, line 10, it says:

"For example, if the basic constituent is lime, the proportions by weight will be approximately 0.7 to 1 part of CaO to one part of SiO_2; and if magnesia is substituted for part or all of the lime, the silica is increased accordingly so as to maintain about the same stoichiometric proportions."

I explained yesterday, I believe, that in the case of magnesium oxide and calcium oxide, the equivalent amounts of those elements would be, in the case of calcium oxide, 56, and in the case of magnesium oxide, approximately 40; so that, in the case of magnesium oxide, we would have to combine it with more silica in order to maintain these stoichiometric proportions than we would have to do if we combined it with calcium oxide, or with manganese oxide.

Q. And what further directions does the patent give, Doctor, with respect to the substitution of still other basic oxides in the place of lime?

A. I am reading now from page 2, column 2, line 25 of the patent:

776 "The basic constituent preferably consists chiefly of lime and magnesia in approximately the proportions of three parts of CaO to one part of MgO, by weight; but other proportions are useful and within the invention.

"Basic materials other than lime or magnesia, for example oxides of manganese, titanium, or the alkali metals, and known fluxing agents such as borax, or boric acid, may be added in moderate amounts without greatly changing the essential characteristics of the welding composition. * * *"

Q. Now, how would magnesium oxide be substituted there, Doctor?

A. Well, I have explained that, in order to substitute magnesium oxide for calcium, we would have to calculate out the molecular weight of magnesium oxide, which is 40, and that of calcium oxide, which is 56; and for every 56 parts of calcium oxide we would substitute 40 parts of magnesium oxide.

Q. And how about manganese oxide; what have you to say with respect to that?

A. Well, in the case of manganese oxide, MnO, we
777 find that the molecular weight of calcium oxide is 56, and that of manganese oxide, MnO, is 71; so for every 56 parts of calcium oxide, we would substitute 71 parts of manganese oxide, MnO.

778 Q. Now, turning to a somewhat different matter here on your explanatory chart, when a chemist sets about making such a material as one of these welding compositions described here, does he begin with the element materials in the top row on your chart, or where does he begin?

A. No, you cannot start with these elements in the top row, because if you fused these together you would not get the composition we wish.

One starts with these, which have been combined with oxygen—calcium oxide, magnesium oxide, manganese oxide and aluminum oxide—and there are two reasons for that: In the first place, as I said, if we started with the elements and fused those into the compound, we would not get the material we seek.

But there is another reason: in commercial work we have to start with material which is available.

Now, calcium, metallic calcium, even if it worked, would not be satisfactory because it is a very expensive material. It is difficult to get metallic calcium. Oxide of calcium is readily available in the form of lime.

779 Lime is a common product, commercially cheap; you can get it in any quantity you want; therefore we would naturally start with lime.

The same with magnesia. Magnesia is a comparatively inexpensive material; oxide of magnesium is abundant in nature in various forms, and we would start with that. Even though magnesium metal could be used—which of course it could not—we would still prefer the oxide of magnesium.

Manganese oxide, MnO, is not available, not a common article. The common oxide of manganese, which occurs in nature, is MnO_2. I mentioned that yesterday, I believe, and stated it was a black material. We could start with that, then, because it is available, and when that is heated with silica, this extra oxygen is lost and it goes back to the state represented by the oxide MnO.

So it would be equally satisfactory to start with MnO if it were available, or we can start with the MnO_2, which

is available, loses its oxygen and goes back to this form, so it makes no difference what we start with.

Q. The patent says, Dr. Willard, on page 3, in the first column, beginning in line 18:

780 "The carbonates of calcium or magnesium may be substituted for the oxides, of course, if the ingredients are prefused."

What do they mean by that?

A. Yes, the carbonates are more available than the oxides, in nature. Limestone is a carbonate of calcium with some magnesium in it; and limestone is very commonly available, widely dispersed in nature, occurs most everywhere. It is one of the constituents used in making Portland cement, so it is probably easier to use calcium carbonate, from the point of view of availability, in the form of limestone, than to use oxide.

Now, it makes no difference which one we use, because when you heat calcium carbonate—the formula for calcium carbonate is $CaCO_3$—when you heat that, it loses carbon dioxide, carbon dioxide as a gas is given off, and we have left CaO, CO_2 being given off and leaving a residue of CaO, which is calcium oxide, so the carbonate is just as good and the same holds for magnesium.

Magnesium oxide is less common in nature than the carbonate. Therefore we would probably prefer to use here magnesium carbonate.

781 There is one type of limestone which has a special name, called Dolomite that contains both calcium and magnesium in approximately equivalent amounts, so if one wants to introduce considerable magnesium that would be a very convenient form in which to introduce it, and Dolomite, again, is a very common type of limestone, ordinary limestone having much less magnesium that Dolomite.

Q. Now, Dr. Willard, on page 2 of the patent at the bottom of the second column there is a tabulation there beneath the paragraph which reads:

"Welding compositions which have been used successfully and which serve as representative examples within the invention have the following analyses, by weight:"

Will you explain to the Court, please, the set up of such analyses as that shown and how they are arrived at?

A. I have already shown that the constituents which we would react together to give a welding composition of the desired formula are the oxides. Now, after these ele

ments are combined it is not easy to write the formula for the combination itself because they can combine in various proportions, and therefore it is customary in analyz-
782 ing a substance to report the constituents in terms of those substances which, if fused together, reacted together, would give a substance having the composition shown by the analysis.

So we report here not the elements themselves, because I have already said that if we heated together the elements, we would not get the proper material, but if we heat together the oxides we do get what we want.

Therefore we report the analysis in terms of the oxides, so on looking over this table we know that if we combine those oxides that are shown there and heat them to a sufficiently high temperature to get a reaction complete, and add calcium fluoride as directed just above, we would have a welding composition of that particular type which is indicated by Unionmelt 20.

Q. Have you made such an analysis of the samples of Lincoln flux that were submitted to us by the Defendants?

A. Yes, I have analyzed the samples of Lincoln flux that were submitted by the Defendants.

Q. You have, I believe, prepared a chart that sets out that material, is that right?

783 A. Yes, that is right.

Mr. Wolfe: I will ask that this chart be marked for identification as Plaintiff's Exhibit No. 194.

(Whereupon said chart was marked Plaintiff's Exhibit 194 for identification.)

By Mr. Wolfe:

Q. What is the material down here in the lower left hand corner of Exhibit 194, Dr. Willard?

A. This material in the lower left-hand corner represents the composition which is shown at the bottom of Column 2 on Page 2 of the patent.

Q. How about the table in the lower right-hand corner of your chart?

A. The table in the lower right-hand corner indicates the analysis of the Lincolnweld 660 flux.

Q. Is that the analysis which you made?

A. That is the analysis which I obtained, yes.

Q. What are these colored figures above those tables?

A. The acidic constituent of the flux, silica, is shown in

blue. The alkaline constituents are shown in yellow—that is, calcium oxide and magnesium oxide—and in the fig-
784 ure to the right, calcium oxide and manganese oxide. The calcium fluoride, the halide salt, is shown in pink. A few impurities are included here in the term "miscellaneous", iron and some minor constituents of less significance. Then, in green, the proportion of aluminum oxide or alumina.

Q. Will you point out in a little more detail for us how those compositions compare there, that is, the analysis from the patent and that of the Lincoln flux?

A. They are both silicates and they both contain calcium fluoride. They both contain calcium oxide.

The formula from the patent contains a large proportion of calcium oxide. The Lincoln flux contains a small proportion of it. The formula in the patent contains magnesium oxide, which is practically absent in the Lincoln flux, and in place of the calcium and magnesium together we have this manganese oxide replacing those two elements; so we have here in one case a silicate of calcium and magnesium with a little aluminum, and with calcium fluoride, and in the case of Lincolnweld we have silicate of calcium and manganese with a little aluminum and calcium fluoride added.

785 Q. How does the Lincoln flux as there shown answer to the directions of the patent for proportion of calcium fluoride?

A. The proportion of calcium fluoride is essentially the same in both cases.

Q. In the case of the alumina, the patent says, and I am reading from page 2:

"The alumina forms about 1% to 8% by weight, of the welding composition, and preferably about 4% to 6%."

How does the Lincoln flux answer in that respect?

A. Well, it is between 1 and 8%; but it is below the 4 to 6%.

Q. What is the value you have there?

A. The value there is 1.88% of Al_2O_3.

Q. Now, you told us before about the directions of the patent for determining the proportions in accordance with —or maintaining stoichiometric proportions.

Have you made any calculation of this Lincoln flux to determine whether or not it follows that direction?

A. Yes, I have. If we substitute the calcium oxide
786 and the magnesium oxide here by manganese in stoichiometric proportions, we get the composition indicated by Lincolnweld 660, so that is simply following the directions of the patent in that respect.

Q. Can you give us your calculations on that in a little more detail?

A. Yes. I can give you the exact calculations.

Mr. Wolfe: I offer this calculation in evidence as Plaintiff's Exhibit 195.

The Court: Is there any objection?

Mr. Byron: Mr. Oberlin would like to look at it just a minute, your Honor.

Mr. Oberlin: We assume that the admission of this exhibit does not prove its correctness. It will take some time to examine these calculations in detail, such as the Doctor on the stand has undertaken to make here. That is his calculation, and I assume that that is all that the offer contemplates.

Mr. Wolfe: That is correct.

Mr. Oberlin: With that understanding we have no objection.

The Court: It may be admitted.

787 (Whereupon said calculation, PLAINTIFF'S EXHIBIT NO. 195, was admitted in evidence.)

The Witness: I might say that the procedure followed in making this calculation is the one that I have illustrated on the board a moment ago. I can go into that a little more in detail. Perhaps it might be worth while to show the figures; do you think so?

788 Q. Yes, do so, please.

A. Well, I have explained before that the atomic weight of manganese is approximately 55, and that of oxygen is 16, so the molecular weight, then, would be 71 for the MnO. This (indicating) is manganese, and this (indicating) is oxygen.

For calcium, the corresponding figure, that is, the atomic weight of calcium, is 40, and we have one of oxygen, which is 16, so that the molecular weight, then, of the calcium oxide is 56.

In the case of magnesium, we have 40.3 for the atomic weight of magnesium, and we have 16 for the oxygen, so we have—or rather, no; I beg your pardon. We have 24.3 here for the atomic weight of magnesium, and we have 16

for the oxygen, which gives us 40.3 for the molecular weight of magnesium oxide.

Now, the stoichiometric proportions in which these will combine with silicon, are the figures given for these molecular weights.

In other words, 71 parts of manganese oxide, MnO, are equivalent in combining power with silicon of 56 parts
789 of calcium oxide, and to 40.3 parts of magnesium oxide.

Therefore, if we take the percentage of calcium, which has been replaced by manganese, which is shown on the sheet here to be 26.84 per cent—this figure is used because there still remains 2.66 per cent of calcium oxide in the Lincolnweld, which has not been replaced by manganese; so that we subtract that, and this 26.84, then, when multiplied by this ratio of 71 over 56, will give us the equivalent of MnO, which is 33.95 per cent.

Now, doing the same thing for the magnesium oxide; practically all of the magnesium oxide in the patent was replaced by manganese, and there remains only a small fraction of a per cent, which I have disregarded here; so we have 8.7 per cent of MgO, and we multiply that, then, and we find that 40.3 grams or pounds of magnesium oxide are equivalent in combining power with silica to 71 parts of manganese oxide.

So that we multiply the amount of magnesium oxide that has been replaced by this ratio of 71 over 40.3, and we get, then, 15.31 per cent of manganese oxide, for the equiva-
790 lent to the magnesium oxide which was replaced.

Then, since we have replaced both calcium and magnesium, we add these two together, and we get 49.26 per cent of manganese oxide, MnO, as the amount which should be present if, following the directions of the patent, we have added—or replaced, rather, I mean to say, the calcium and the magnesium, by manganese in stoichiometric proportions.

That is the figure we should have.

Then, we find, by analysis, that we actually have 48.19, which, in a commercial product, is identical with the 49.26 per cent of manganese oxide calculated, because there is always a small variation in making up these products. You can't make this up like you would a prescription, because it varies somewhat; and different samples being used for flux, either Unionmelt flux or Lincolnweld 660, would vary more than this in their analysis.

Q. Now, Dr. Willard, the patent, in connection with

reasons for making various changes in the welding flux, says, on page 2, in the first column—I am reading beginning with line 56:

"The particular composition that is to be used is
791 determined by the quality and thickness of the metal plates to be welded, by the current and voltage to be used, and by the properties it is desired to impart to the weld metal."

Now, can you give us an example of a variation in the chemical constitution of the flux to accommodate those various requirements that are set out there?

A. Yes. If we make certain substitutions here, we will change somewhat the properties of the welding compounds. The addition of manganese in place of the—the substitution of calcium and magnesium by manganese results in a flux having a lower melting point, for one thing, which probably would be more useful in welding thin plates at high speed.

Q. How about the properties of the welding metal?

A. And the properties of the welding metal would be somewhat influenced by the composition of the flux.

That is, if we have a flux high in manganese, as is the
792 case with Lincolnweld 660, we will introduce small amounts of manganese into the weld metal and, in many cases, this results in an improved—an improvement in the properties of the metal.

Q. Now, in connection with an analysis of this Lincoln flux, counsel for defendants forwarded to us in a letter under date of December 20, 1946, a photostatic copy of a paper which is headed "The Textor Laboratories, Report of Analyses". You have examined that analysis, have you?

A. Yes; I have a copy here.

Q. Now, what do you, as a chemist, have to say as to what analysis shows as it appears on the paper there, Dr. Willard?

A. Perhaps we should have a copy for the Court.

Mr. Wolfe: I will offer a copy of this analysis in evidence as Plaintiff's Exhibit 196.

Mr. Oberlin: How was it identified in the report, by a number of the laboratory, or otherwise?

Mr. Wolfe: Laboratory No. 72,277. Any objection?

Mr. Oberlin: No.

The Court: Admitted.

793 (Whereupon the said document was marked PLAINTIFF'S EXHIBIT 196 and admitted in evidence.)

The Witness: In looking over this analysis, I find that it foots up to much less than 100 per cent, so naturally one wonders what is lacking here. It might appear first to be the analysis of an alloy in which the elements are present as such.

A more logical way to report the analysis, as I have said before, is to report them as oxides, because then when one foots up the total it should come up approximately to 100 per cent, within the limits of experimental error, if one has made a complete analysis.

By Mr. Wolfe:

Q. What is the common practice of reporting analyses of silicates?

A. The common practice is reporting them in the form of oxides.

I would like to quote a passage from a book by Washington, bearing on that subject.

Q. Is that a recognized authority on the subject?

A. Yes. It is a book by Washington entitled "The
794 Chemical Analysis of Rocks", a recognized authority on the analysis of silicates and other types of rocks.

This book—I will identify it a little more—is by Henry S. Washington, the fourth edition, "The Chemical Analysis of Rocks", published in 1930.

On page 23, about the middle of the page, I am reading one paragraph under the heading "Statement of Analyses":

"The results of the analysis might be stated in terms either of the elements present"—which is the form in which this is reported.

Q. That is Exhibit 196?

A. Yes.

"—or of the basic oxides and acid radicals. Though the former may be the more logicial on purely theoretical grounds, yet the latter greatly facilitates calculations based on the analytical data, and being universally in use, renders comparison of all rock analyses with each other very simple. It is therefore to be adopted without ques-
795 tion."

Q. In examining that analysis, Exhibit 196, Dr.

Willard, have you made a calculation converting those reported single elements into oxides, so that it can be compared with your oxide analysis?

A. Yes. I have calculated the elements here to the form of oxides, and I have a sheet here in which this comparison is given.

Mr. Wolfe: I will offer that calculation sheet in evidence as Plaintiff's Exhibit 197.

Mr. Oberlin: This again has been presented as calculation made by the witness?

Mr. Wolfe: That is correct.

Mr. Oberlin: They are not necessarily correct. With that understanding, they may be received.

The Court: Admitted.

(Whereupon the said sheet was marked PLAINTIFF'S EXHIBIT 197 and admitted in evidence.)

By Mr. Wolfe:

Q. Now, you have several columns there on Exhibit
796 197. Will you just point out for the Court what those are.

A. Yes. The first column represents the oxides which are present in the flux.

The second column represents the percentages of these oxides which I obtained in my analysis, and the percentage given in the third column represents the values obtained by the Textor Laboratories.

Q. There seems to be some variation in those numbers, on comparing the last two columns. Are there any significant variations there?

A. No. The analyses are in satisfactory agreement. One would not expect complete agreement between analyses of a complex silicate like this, from two separate laboratories; and I will say the agreement is entirely satisfactory.

Q. Now, this Textor analysis has an item on there "available oxygen". What does that mean?

A. Available oxygen in this case can apply only to the oxide of manganese. I have already pointed out and explained that manganese can form several oxides, MnO is the one we are concerned with here primarily, but I have explained also that there is an Mn_2O_3, Mn_3O_4,
797 MnO_2 and even Mn_2O_7, which is the purple volatile liquid which I mentioned.

Now, "available oxygen" means that amount of oxygen

which is greater than the one atom combined with manganese in the formula MnO.

Suppose we illustrate this by taking manganese dioxide, which I mentioned before, a common mineral; and we have two atoms of oxygen combined with one of manganese, and the available oxygen then would be this extra atom of oxygen above that in the formula MnO.

798 That is, one atom of oxygen, then, would be available, as we call it. The reason that we use the term "available" is that manganese dioxide is often used as an oxidizing agent, as a means of supplying oxygen to other materials.

Since we cannot go below one atom of oxygen to one of manganese, but we can go that far, this extra oxygen can be given off by heating, or by chemical reaction, so that it can be used as a means of generating oxygen, and therefore we call it available oxygen.

That one atom is available for purposes of furnishing oxygen as a gas, or, more commonly, as a means of oxidizing some other substance.

Now, if we took one of the other oxides of manganese, suppose that we take, for example, Mn_3O_4. Since there are three atoms of manganese here, that would be the same as writing 3 of MnO, plus 1 of oxygen, so that would mean, then, that in one molecule of Mn_3O_4 there would be one atom of available oxygen.

But proportionately, there would be less than in MnO_2, because you see we have 3 of manganese here, and these three of manganese, then, would only have one of

799 available oxygen, whereas the MnO_2, 1 of manganese, had 1 of available oxygen.

Therefore the amount of available oxygen in this oxide would be less than it would be in MnO_2, which is the mineral that I have referred to previously.

Q. What does that item in the analysis indicate, Doctor, with respect to the constituents present in the Lincoln flux?

A. It indicates that there probably is present a higher oxide of manganese, and we know that manganese silicate, when fused and allowed to cool, will take up a little oxygen from the air.

Exactly in what form that exists, we do not know. All we know is that it contains a little more oxygen than would correspond to the oxide MnO.

Q. What is the percentage that is given there for that, Doctor?

A. Well, since Mn_3O_4 is an oxide of manganese, which is fairly stable at high temperatures, we may assume it is present in that form; and that would mean, then, that we had in there about 4% of Mn_3O_4, in the mixture, which is a very small proportion of the total manganese present.

800 Q. Irrespective—

A. I might say that if we heat Mn_3O_4 to a sufficiently high temperature it will lose its oxygen, that extra atom, and go to the MnO form. It is possible, if the temperature is not too high, to have a little of this oxygen taken up again as it cools to form a little of the higher oxide.

Q. Irrespective of which oxide of manganese you start with, if you fuse it with silica what oxide do you have in the fusion?

A. As I have already explained, even if we started with manganese dioxide, the mineral—and that is commonly used as a raw material here—when it is combined with silica at this very high temperature, the oxide then which is combined with the silica is practically all MnO.

Q. Dr. Willard, how do the bivalent oxides of calcium and magnesium and manganese, to which you have been referring, compare chemically?

801 A. Well, they are all three basic in their reactions. They all have a valence of 2. They all combine with silica to form fusible silicates.

Manganese, as I have pointed out, has several possible valences, but it does not make much difference which one we start with. It is more a matter of availability than anything else, because in the case of the higher oxides, oxygen will be lost, and so we get down to the bivalent form anyway.

802 Then in the case of manganese and magnesium, there is quite a similarity in many of their reactions. That is, the analyst, when determining them gravimetrically, weighs them in the form of pyrophosphates, both of them; and there are other similarities in their reactions.

There is a difference, of course, as one would expect, between different elements, especially in the case of manganese, due to the fact that it can form higher oxides, whereas the calcium will at most only form one oxide.

Q. Is there some simple test which you can perform

for the Court here, Doctor, to illustrate the similar basicity of magnesium oxide and manganese oxide?

A. Yes, sir, there is; there is a very simple test which can very easily be performed right here, if I may, and I will be very glad to do that.

Q. If you will.

A. I explained yesterday, I believe, that an alkaline substance has the property of turning litmus paper, which is already red, blue; and an acid, the property of turning litmus paper which is blue, back to red again.

Therefore I thought that it might be interesting
803 to apply that reaction here. It is a very simple test.

Q. Now, will you tell us what you are doing there step by step for the record, please, Doctor.

A. Yes, sir.

Mr. Oberlin: Counsel, will there be a residue of those materials which the witness is going to use in this test, or whatever you want to call it, available for check?

The Witness: Oh, yes.

Mr. Wolfe: Surely.

The Witness: Yes.

Mr. Oberlin: Very well. They will be retained, will they?

The Witness: Oh, yes, indeed; he may have them, if you wish.

Mr. Oberlin: I just wanted to be sure that there would be enough left over to make an examination of them.

The Witness: Yes, indeed.

By Mr. Wolfe:

Q. Will you proceed, please, Doctor.

A. Now, I have here a little beaker—these are
804 the vessels that we commonly use in chemical experiments, which we call beakers.

I have here a bottle of distilled water. I use distilled water here in order to be sure that there are no foreign ingredients in the water.

I put a little water into the beaker, and I will add to that—or rather, I will dip into it, a piece of this red litmus paper. You will notice that it is still red; it does not change at all.

Now, I have here some manganese oxide, MnO, and I will put a little of that in here, and stir it up for a moment; and I think it is quite obvious that this half which was in the liquid, has now turned blue.

That is a familiar test that chemists use, to denote an alkaline substance, and that shows that this oxide of manganese, MnO, which is the same material that was on the board here, in the second row, the third tube from the right—the same material—is alkaline.

Now, I have another beaker here, and I will do the
805 same thing with magnesium oxide. Again using distilled water, I dip in here a piece of litmus paper, which is now red, and it stays red in the distilled water.

Now, I will add magnesium oxide, a little magnesium oxide, this white powder, and I will stir it up, and give it a little time to react here, and that will have a similar effect. It does not react quite as rapidly as the manganese oxide.

Again, here we have this strip of litmus paper turning blue. I raise it out of the liquid, showing that it is blue.

That indicates, then, that both of these oxides, when moistened with water, give an alkaline reaction.

806 Now, I am using the terms "alkaline" and "basic" in the same sense. This reaction has been carried out in a water solution. In the reaction to form a welding flux we, of course, do not use a water solution because we are working at a high temperature, but the fact that the oxide, when treated with water, has an alkaline reaction is justification for stating that it is an alkaline oxide and that it is basic in its reaction.

With respect to the term "basic" I think I should indicate that I am using it here in a limited sense as meaning that the substance is alkaline and can react with an acidic substance to give a salt. In other words, the acidic substance is silica and the salt is a silicate.

Q. Now, Dr. Willard, aside from your chemical analysis of the Lincoln flux that you told us about and your examination of the substances, have you taken any other steps to verify your analysis?

A. Yes. After analyzing this flux I had this material synthesized, adding ingredients as found by analysis. In this production of the synthetic flux we started with manganese dioxide as the sources of manganese. We
807 started with sand as the source of silica, with lime as the source of calcium and with a little bauxite as the source of aluminum.

Bauxite is a mineral which is a hydrated aluminum oxide, and which is used as a source of aluminum commercially and in the manufacture of metallic aluminum.

Then to this was added a small percentage of calcium fluoride. These materials were fused together in an electric furnace and poured out on to a cold plate, then ground up so as to be in a granular form, and then were analyzed to make sure that they had the right composition.

Q. How did the product of that work compare with the samples of Lincoln flux?

A. It had the same composition, within ordinary limits, as the Lincoln flux.

Q. Now, I would like to turn to another phase of the patent with you, Dr. Willard. On page 2 in the first column beginning at line 38 the patent says, and I will read the paragraph:

"A large number of experimental welds which we have made support the conclusion that the properties of a
808 successful welding composition for this method of welding are these:

"(1) The chemical reactions between the components of the welding composition must be completed before it is used in welding. Failure in this regard most surely invites porosity.

"(2) It must be capable of controlling the penetration and the width of the weld.

"(3) Its fluidity at welding temperatures must be such that it will not become entrained with the molten metal.

"(4) It must consist of chemicals which are not detrimental to the properties of the steel, and.

"(5) It must be readily removable from the finished weld."

Now, will you tell us whether or not the Lincoln flux which you have studied answers any or all of those property requirements?

A. Yes. It answers all of those essential requirements.

809 Q. Now, are you able to say whether or not this Lincoln flux is a prefused material?

A. Yes. This is a prefused material. We know that because unless the elements are combined at a high temperature and fused, there is no reaction between them. Also we know that it is not a material which exists in nature, that you can go out and dig out of the ground, or anything of that kind. It has to be prepared artificially, and to do that fusion is necessary.

Q. You mentioned at the outset of your testimony cer-

tain precautions which the patent gives. Will you point those out to us, please?

A. Yes. The precautions are mentioned on page 3 in Column 1, lines 4 to 11. It states there:

"The chemical condition of the welding composition or medium is important: the acidic and basic constituents should be reacted, the composition should be substantially anhydrous and free from gases, and all reactions which would evolve deleterious amounts of gases during welding should be substantially completed, before the medium is used in the welding process."

810 Also in Column 2 on page 2, lines 35 to 42, reading:

"* * * but it is important that the composition be substantially free from iron oxides uncombined with other ingredients of the composition (by being prefused with such ingredients, for instance), and from materials (such as carbonates or moisture) which evolve detrimental amounts of gas or vapor at welding temperatures."

811 Q. From your examination of the Lincoln flux, can you state whether or not these precautions of the patent that you have referred us to were observed?

A. Yes. They seem to have been well observed.

Q. Is the Lincoln flux anhydrous?

A. Yes. The Lincoln flux is anhydrous.

Q. Is it free from iron oxides uncombined with other ingredients of the composition?

A. Yes. It is free from iron oxides which are uncombined with the other ingredients.

Q. Referring to page 3 of the patent, the paragraph following the paragraph that you read to us on precautions, in line 21 begins:

"The physical condition of the welding composition is likewise of the utmost importance. If the molten medium is rapidly solidified by cooling, before grinding and use, more homogeneous and solid welds may be produced than when it slowly loses heat and solidifies. The fused composition is preferably cast as a relatively thin layer against efficient cooling or chilling means such as a cold heavy plate

or block of metal, or a water-cooled chill plate, rather
812 than as a large ingot. It is preferred that the rate of cooling be such that substantially all of the solidified welding composition is characterized by a vitreous fracture."

What is meant by "characterized by a vitreous fracture"?

A. Vitreous fracture means a fracture which is the type of fracture one would get when he breaks a piece of glass. That is where it gets its name from, the term "vitreous".

This is quite different from a crystalline material which has a different structure. We can classify materials roughly into crystalline materials which have a definite structure, and non-crystalline or what we call amorphous materials which do not have any crystalline structure.

Glass is a very good example of the latter type. In fact, glass would not be of any value at all if it were crystalline, because it would be more or less opaque.

Q. Have you examined the Lincoln flux to determine whether it is characterized by a vitreous fracture?

A. Yes, I have, and it is characterized by a vitreous fracture.

813 Q. You had a specimen here, I believe, that you said we could see a comparison of vitreous fracture and crystalline structure in. Is that the specimen (handing article to witness)?

A. Yes. This is the specimen.

Q. What is that, please?

A. This is a sample of Lincoln melt which has been poured out on a plate and allowed to cool. The top portion of this which cooled quickly has a glassy appearance.

The middle part, which cools slowly, is totally different in appearance, and is crystalline.

Mr. Wolfe: I will offer that specimen in evidence at this time, your Honor, as Plaintiff's Exhibit No. 198.

Do you care to examine it, Mr. Oberlin?

Mr. Oberlin: It is not clear from any question that has been asked the witness up to the present moment, as to what this was derived from, or where. The witness says that it is a specimen of Lincoln flux, but it does not look like the material that has been stipulated.

814 The Witness: That was the synthesized Lincoln flux that I mentioned a moment ago.

Mr. Oberlin: The Lincoln 660 flux, do you mean?

The Witness: Yes, sir.

Mr. Oberlin: We object to it without having had an opportunity to examine it critically, to ascertain whether it is a true specimen or not, and we cannot do that by any mere inspection at the present time.

If it is tendered merely as something which the witness says he made, that is all right.

Mr. Wolfe: The only purpose here is to illustrate the contrast between vitreous and crystalline structure.

Mr. Oberlin: Irrespective of whether it is Lincoln 660 flux, or what it is?

Mr. Wolfe: Yes.

Mr. Oberlin: All right.

The Court: Admitted.

(Whereupon the said specimen was marked PLAINTIFF'S EXHIBIT 198 and admitted in evidence.)

815 By Mr. Wolfe:

Q. Now in this case, Doctor, we have had quite a lot of reference to clay fluxes.

Will you tell us whether natural clays are crystalline or amorphous in structure?

A. Natural clays are more or less crystalline in structure.

Q. Aside from the inspection of a specimen such as this Plaintiff's Exhibit No. 198, do you chemists have any technique for examining materials to determine whether they are crystalline or vitreous?

A. Yes, sir, we have a very effective technique, which we call X-ray diffraction.

Q. And what do you do in that technique, Doctor?

A. If we allow a beam of X-ray to strike the powdered material, those rays, if we are dealing with an amorphous, non-crystalline substance, will come out at random, and show no definite pattern, because in an amorphous substance, the atoms are arranged more or less in a helter skelter manner, and not in any definite pattern, so that the X-rays simply go in all directions, and we get no pattern at all.

If, on the other hand, we have a crystalline ma-
816 terial—pardon me; I think that if I had my model here, it would illustrate this very much better.

Q. Is this (indicating) the one you refer to, Doctor?

A. Yes, sir. This is a model, showing the arrangement of the atoms in a crystal of sodium chloride, or common table salt.

Salt is made up of chlorine and sodium atoms. The large green balls here represent the chlorine atoms, and the smaller gray balls represent the sodium atoms; and in the entire crystal, the entire crystal of salt, the atoms are arranged always in this definite pattern.

817 Of course, this would be built up many times, but the structure in general would be the same.

We will have here at one corner a chlorine atom; at another corner a chlorine atom, and between them an atom of sodium.

You will notice here we have layers of these, a layer on top, a layer below it, and then another layer.

Now, when the X-rays, which have a very short wave length so they can penetrate in between the atoms, when they hit one of these planes, they are diffracted in a definite direction, and the ray is then allowed to fall on a photographic film, and we get then a series of circles, the lines of which are spaced in a very definite manner, depending upon the arrangement of these planes in the crystal.

The distance between these lines and their spacing is characteristic of a given substance. Therefore if we get a pattern of this sort, varied with different lines, concentric circles, we know we are dealing with a crystalline substance, because if the atoms are not arranged in
818 a definite pattern but in an amorphous non-crystalline helter-skelter mass, then we get no pattern, because the rays are reflected in a helter-skelter manner.

Now, if we examine a specimen of clay in this way, we find it gives a pattern of lines, which indicates its structure is crystalline.

If we examine a specimen of Uniommelt or Lincoln flux, it gives no pattern, showing it is not a crystalline substance and, according to the patent, of course it should not be, because it has been quickly cooled and not allowed to crystallize.

In other words, this little specimen here, the crystalline structure in the center is what we do not want. The crystalline structure in the center would show an X-ray pattern. The glassy material on the top would not show an X-ray pattern; so we have a very easy way in that manner of distinguishing between crystalline and non-crystalline materials.

Q. In the early part of your testimony, Doctor, you referred to some ten items in the directions of the patent, as to the constituents, and difficulties and precautions, and so on. Are there any of those which you found not
819 to be observed in the Lincoln flux?

A. They all seem to be well observed in the Lincoln flux.

Q. In order for a chemist to prepare the Lincoln flux, having been given the directions of the patent, is there any independent experimental work which he would have to do?

A. No, a chemist would not have to do any experimental work. He would take the preferred formula given in the patent.

He would see, if he wanted to make a substitution of manganese for calcium and magnesium, he must do it using stoichiometric proportions. He would calculate out then what the proportion of manganese should be.

The patent tells him how he should react these materials. It tells him exactly how much calcium fluoride to add; tells him how much aluminum oxide should be present; tells him these materials must be fused, poured out on a cold plate, fused rapidly.

I see no reason why a chemist should have the 820 slightest difficulty in following those directions.

Q. One last item: In your analysis tabulation of the Lincoln flux on the chart, Exhibit 194, you have listed calcium fluoride, giving its percentage as 3.92. Are you able to determine the presence or absence of calcium fluoride, as such, in this Lincoln flux?

A. Yes, I am able to do that, by using the method of X-ray diffraction which I have just described.

In order to accomplish this, I took Unionmelt—I should say, Lincoln flux, crystallized it, powdered it, and examined it in an X-ray beam, and found that it gave a diffraction pattern, which, by comparison with calcium fluoride, proved to be identical with that; and there are no other elements in this flux which could give a compound having this pattern, which is characteristic of the crystalline calcium fluoride. So this identifies it without any question, as such.

Moreover, we made a further test. Another property of crystals is they show a certain characteristic constant, which we call index of refraction.

I will have to explain that term a little. If a beam 821 of light passes from air into water, you know it is bent. As you know, looking at an object in water, you can't always be sure where it is, looking from above. The extent of the bending of the ray of light when it passes from one medium to a rarer or denser one is measured by what we call index of refraction, and this index of

refraction is a constant which is characteristic of certain substances, like the melting point, specific gravity, or any one of a number of physical constants.

Now, in this case we measured the index of refraction of the calcium fluoride in this powder, this powdered, crystalline Lincolnweld flux, and we found that it was between 1.43 and 1.47.

Now, we know that in the fluoride free flux, there was no material with a refractive index as low as 1.47; but we found that the flux in which calcium fluoride was known to be present, we found the presence of isotropic—and this term isotropic refers to this structure of crystal—isotropic particles, with a refractive index slightly below 1.44 and above 1.43.

822 Now, the refractive index of pure calcium fluoride is well known and is given in this book as 1.434; therefore these particles were undoubtedly crystalline calcium fluoride.

So we have two pieces of evidence that the calcium fluoride does exist as such, in Lincolnweld 660.

823 Q. Doctor, in checking over your calculations on Plaintiff's Exhibit No. 195, was there some alteration that you desired to make?

A. Yes, sir. I find that I made a slight error there, and I would like to have the opportunity to correct it, but it will take me a little time to go over it. I would rather not do it now, rather not take the time now, but I will do it during the lunch hour.

Mr. Wolfe: Other than that, may it please the Court, I have finished with my direct examination.

824 *Cross-Examination by Mr. Oberlin.*

Q. Dr. Willard, is or is not manganese an alkaline earth metal?

A. In a strictly chemical sense, I testified that alkaline earth metals—

Mr. Oberlin: I object to the answer as not responsive, your Honor. That question can be answered by yes or no.

Mr. Cahill: I submit, may it please the Court, that there is no requirement upon the witness to answer that sort of a question yes or no.

The Witness: No, I do not think that the question can fairly or intelligently be answered yes or no.

The Court: Well, not what you testified. You can answer the question more directly than that.

825 A. I think that in the sense of the patent, it should be included as an alkaline earth metal,—in the sense in which it is used in the patent.

By Mr. Oberlin:

Q. Will you name us the alkaline earth metals as they are listed in the chemical text books used for the instruction of students in the University of Michigan?

A. Well, some of them refer to barium, strontium, calcium and radium, and some others leave out radium and include beryllium.

There is some variation there.

Q. But none include manganese; is that correct?

A. Not directly, no, not directly.

Q. Is there any list that includes manganese as an alkaline earth metal that you know of?

A. I would like to quote to you from—

Q. I am asking you the question, if there is any list that includes manganese as an alkaline earth metal, in any chemical text book?

A. That is what I would like to answer you. If you will give me just a moment, I will have the book here.

826 Mr. Wolfe: Which book is it that you want, Dr. Willard?

The Witness: Smith's College Chemistry.

Mr. Wolfe: Here it is.

Mr. Oberlin: May I see the book, please.

The Witness: Yes, certainly.

By Mr. Oberlin:

Q. That book is not from your university library, is it, Doctor?

A. No, sir, but we used this book for many years as a standard text in the university.

The Court: Is there a question pending, Mr. Reporter.

(The question was read as follows:

"Q. Is there any list that includes manganese as an alkaline earth metal that you know of?")

A. The answer was—or the answer is, not directly; but I would like to read from the bottom of page 685 of this book, as follows:

"It will be seen that the element manganese changes its character totally with change in valence, and in each form

of combination, resembles the same set of elements
827 of valence identical with that which it itself has assumed."

Now manganese, with a valence of 2, then, has more similarity with the elements, these other elements which I have discussed, with a valence of 2.

By Mr. Oberlin:

Q. And that is the nearest citation which you can find, of any authority which would place manganese in the list of alkaline earth metals; is that correct?

A. Oh, I have seen one or two other statements, but none of them that are much different than that.

Q. And they do not mention alkaline earth metals in the statement which you have just quoted, do they?

A. No, sir. It just discusses the similarity in property.

Q. Now, the patent in suit emphasizes as quite important, the composition of this welding medium about which you have been testifying, does it not?

828 A. Yes, but of course it gives certain limits. I do not know how critical you desire to be—

Q. As a matter of fact, the statement in the patent specification is that the composition is of the utmost importance; that is correct, is it not?

A. Yes, sir, but of course, as I say, certain limits are given. He does not specify an absolutely rigid composition.

Q. And by "composition" of a welding material, or
829 any substance, what is meant?

A. I would say that composition means—well, the easiest way to express composition, that a chemist ordinarily uses, is to make an analysis of it, and list the analysis.

That is ordinarily considered the composition.

830 Q. That is, of the elements present in the material?

A. Well, of the materials present in it, yes, if he knows what they are.

Q. Well, the ultimate analysis would be the elements that are present in the compound, would that be true?

A. Well, the analysis would not be entirely complete if you just listed the elements, because there is oxygen in there, too.

Q. Well, oxygen is an element, is it not?

A. Yes, but it was not listed in all the analyses.

Q. I am not referring to any specific analysis. We are talking about them generally.

A. Yes. You should list all the elements present. That is right.

Q. That is the first step to any analysis?

A. That is right.

Q. Until you ascertain what elements are present you cannot determine what the compound is, chemically speaking, can you?

A. That is true. You must know what elements are present.

Q. So when we are talking about composition being of the utmost importance, we are talking about the
831 elements present, are we not?

A. Yes. That is part of it.

Q. Now, Doctor, during your direct examination your attention was called to that table giving the analyses of welding compositions which the patentees stated they had successfully used. I refer to the table at the bottom of the second column. Let us discuss that in terms of ordinary English instead of the chemical formulas that are given there for the materials found in these successfully used compositions. There are four columns there of figures which represent four different compositions, is that correct?

A. That is correct.

Q. In the lines opposite those figures thus columnized are given the composition of the ingredients that enter into each?

A. That is right.

Q. Those ingredients are given in chemical formula?

A. That is right.

Q. The first one: What is it, in ordinary English? CaO?

A. CaO is ordinarily called lime, I think. That is not a particularly good term, because lime can be either
832 calcium oxide or it can be slaked lime which is calcium hydroxide.

Q. Well, the formula there would indicate that this was unslaked lime, would it not?

A. That is right. When you give the formula in distinction to the ordinary every day name, you have characterized it very specifically.

Q. Well, that first ingredient then, with respect to

which varying percentages are given under the vertical columns 1, 2, 3 and 4, is unslaked lime, is that right?

A. That is right.

Q. And the second one, MgO is what we ordinarily call magnesia?

A. That is right.

Q. You have used that term in your testimony?

A. That is right.

Q. The third, SiO_2 is what you have called silica in the course of your testimony?

A. Yes.

Q. That would be pure sand?

A. Yes.

Q. From the shore of Lake Michigan or wherever obtained, is that correct?

833 A. Well, most sand is not entirely pure—

Q. I said pure—

A. —but it is essentially silica.

Q. The fourth ingredient is Al_2O_3; that is what?

A. That is alumina, aluminum oxide.

Q. Which you have also referred to as bauxite, I believe?

A. Well, bauxite is not quite the same thing. That is, it has a good many other things in it. It is primarily aluminum oxide with considerable water combined with it, and various impurities. It is just an ore.

Q. I only mentioned it because you did, as I remember it, during your testimony.

A. I said it could be used as a source of aluminum.

Q. It is naturally occurring alumina with some impurities?

A. Yes, with many impurities, including a lot of water.

Q. The final ingredient of the five is Fe_2O_3. What is that?

A. That is ferric oxide.

Q. That is a form of iron rust?

A. Yes. That is one of the forms of iron rust.

Q. Of these five ingredients, Dr. Willard, the amount of iron rust used in the compound is apparently quite

834 insignificant. I assume that is present merely as an impurity?

A. No. It is not present as such because the patent states in line—let me see.

Q. I think the question was, is that merely present as an impurity?

A. Oh, yes. That is present as an impurity. A small amount of it does no harm if it has been fused into the material, but the patent states it should not be present in an uncombined form.

Q. Well, all of these ingredients that we have been discussing in this list are presumably combined in this fluxing material?

A. Oh, I think so, yes.

Q. None of them are separate?

A. No.

Q. That is, there is no calcium oxide there, or lime as such?

835 A. No. It is combined to form calcium silicate

Q. Nor magnesia?

A. That is right.

Q. Nor alumina?

A. That is right.

Q. And this iron oxide, I assume, is likewise combined?

A. I think so.

Q. The whole combination inclusively you call what?

A. I would call the whole thing calcium magnesium aluminum silicate.

Q. Including iron oxide?

A. Including iron oxide, because it is a minor constituent, and also because we have not added here the halide salt calcium fluoride.

Mr. Oberlin: We will come to that later.

By Mr. Oberlin:

Q. Now, the alumina is present in a rather small amount, from a little over 4 per cent to not quite 6 per cent, as listed in these four columns?

A. Yes.

Q. Is that correct?

A. Yes. The patent limits you—

Q. Is that correct?

836 A. Yes. It is between 1 and 8 per cent, as the patent states.

Q. Where the patent refers to this alumina as an ingredient in the compound, the ultimate compound made by fusing all of these together, or otherwise—I am referring now to column 2 on page 2, beginning at line 54, where the patent states:

"The materials used were of the purest quality used in the ceramic industries, but the fused product showed the presence, on analysis, of about 5% alumina."

Would you deduce from that statement that the patentees deliberately added alumina to their composition or that they merely found it present?

A. Well, I recall Mr. Kennedy's testimony on that, that they originally thought that they had pure calcium oxide and they got it from a firm nearby which made ceramic materials, and when they did not get the right results that they expected, they examined this material chemically, had it analyzed, and found it did contain 5 per cent of alumina. I do not think they—

837 Q. I am not asking you to analyze the testimony of the witnesses previously on the stand. I am asking you from the statement of the patent—that is what we are considering this morning—do you adduce that the patentees deliberately added alumina?

A. I think they either added it or had it present in one of the materials, because the patent states there should be from 1 to 8 per cent of it. If you use the pure material—

Q. They found, apparently, that alumina was in the purest, select quality they could get; and with the other ingredients you think there was that much alumina present?

A. In that particular product, yes. I think that is a rather unusual percentage. Limestone with that per cent would be rather unusual.

Q. You consider the alumina an inconsequential ingredient of this product as tabulated in column 2 on page 2 of the patent?

A. The patent says it should contain up to 8 per cent, so I assume a little would be desirable.

Q. Up to 8 per cent?

A. As high as 8 per cent. That is the maximum.

838 Q. Now, there is no question about calcium being an alkaline earth metal, is there, in this chemical literature you were talking about?

A. No.

Q. And the composition that is shown in four different analytical forms in this table would be properly characterized as an alkaline earth metal silicate?

A. Oh, yes, I think so.

Q. What about the magnesia? Is that also an alkaline earth metal?

A. Many authorities include magnesia in the alkaline earth metals.

Q. Can you determine from the data given in this table whether there is a magnesium silicate, an alkaline earth metal silicate present in a predominant or major proportion?

A. Yes, I would say it is present in a major proportion, because the calcium oxide magnesium and the silicate together make up the bulk of the material.

Q. Would the calcium, magnesium oxide and the silica combined with alumina constitute a major proportion of the final composition?

A. Yes. There is more calcium than magnesium.

Q. So that you do not need to consider the magnesia
839 as a constituent in order to arrive at a composition here having a major proportion of alkaline earth metals? The calcium oxide with the silica and alumina combined, would make such a product?

A. They would make the alkaline earth silicate, if that is what you mean.

Q. I mean in which that was a major proportion?

A. That is the major proportion; and if there was no magnesia, it would still be the major proportion.

Q. Now, you say that this composition of which these are constituents, this lime, this magnesia, silica, and so forth, is a silicate. How do you know a silicate when you meet one?

A. Well, the only way I would know it was a silicate is to analyze it.

Q. Well, you analyze this material and you find a number of materials present?

A. That is right.

Q. But the silicate is a particular combination of those elements, is that not true?

A. That is true.

Q. How do you know, I ask again, that it is a silicate and not a mixture of these oxides, for instance?

840 A. Well, a mixture of these oxides would be very easy to identify, because calcium oxide would be separated out mechanically or chemically from it, as such, and there would be no question about it at all, if they were combined in a mechanical mixture. It would be a very simple thing.

Q. Well, you can fuse or combine in a single mass substances that are not directly separable, as such, can you not?

A. You could, but—

Q. Liquid mixtures, for instance?

A. Oh, yes. You would have some trouble separating liquid mixtures, that is true. This is not liquid.

Q. Is silicate a rather distinct class of compounds in chemistry?

A. Yes, a rather large class of compounds.

Q. That was going to be my next question. They are very numerous?

A. Yes, one of the most numerous known.

Q. One of the most numerous classes of inorganic minerals?

A. Yes. Silica is a very large constituent of the earth's crust, so there are many silicates in nature.

841 Q. Many of the naturally-occurring silicates are known as minerals, are they not?

A. Oh, yes.

Q. And how many well known silicates, minerals, are there, would you say, commonly known?

A. I don't want to make an estimate of that. I know there are a great many, but I don't think I could make an estimate that would be sufficiently accurate.

Q. Well, if I call your attention to a book on mineralogy, by Kraus, Hunt and Ramsdell, published in 1933, in which there is listed, on pages 335 and 336, under the heading "Silicate Minerals", followed with this statement "The following minerals include the most abundant and important silicates", if I tell you there were 55 there listed, would you say there were at least that many commonly known silicate minerals?

A. I certainly have no reason to doubt the accuracy of the statements in there.

Q. Have you had any particular or special experience in working with silicates, as such, in the practice of your profession?

842 A. Oh, yes. Silicates are so common I have had occasion to analyze a great many of them, and use them in many ways.

Q. Are you familiar with the industrial uses made of silicates?

A. Some of them.

Q. Well, all of these silicates listed here as naturally

occurring minerals we have in the composition of the patent?

A. No, I don't think so.

Q. Even if calcium fluoride is added?

A. Even if calcium fluoride is added, I don't think that we can have them.

Q. There are many of them here that probably would not serve?

A. That is right.

Q. At least you could not ascertain if they would serve without testing or experiments?

A. I would prefer to analyze them first and find out.

Q. You would have to analyze them first?

A. I think it would be better, if you want to be sure of your composition, to analyze them first.

Q. Assuming you verified the composition—and this table gives the composition of each of these naturally-
843 occurring minerals, does it not?

A. Yes. Of course, you must remember minerals, as they occur in nature, are never pure.

Q. I am assuming you verified the analysis and know what you are dealing with.

A. Yes.

844 Q. Even then do you know whether it is going to work in this flux in the patent?

A. I think you would know if it would work, if you had the analysis and knew the proper proportions. Yes, I think you could tell.

Some of your silicates are rather unusual, and I don't think they would be of any value commercially, because they are not common enough. For commercial purposes you want something abundant.

Q. I am not talking about commercial use. Please confine your answers to the questions.

A. All right.

Q. Will you tell me whether Vesuvianite will work the formula being given in here, and assuming that the material had that formula, was found to have that formula, by analysis.

A. No, I don't think that would work.

Q. It is a silicate, is it not?

A. Yes, it is a silicate.

Q. It is a metallic silicate, is it not?

A. Yes.

Q. Would it work if you add calcium fluoride in the amount called for by the patent?

A. No; because there is already fluoride in it.

845 Q. But it wouldn't work?

A. I don't think it would work, because I don't think you would get the right proportions.

Q. In addition to the naturally occurring silicates, Dr. Willard, there are a host of what we call synthetic silicates, materials made in laboratories or synthetically?

A. Yes; we could make a large number.

Q. Probably thousands of them?

A. I don't know if there are thousands known, but I see no reason why there couldn't be a great number.

Q. The list has been added to as research progresses in the organic and equally in the inorganic field?

A. The number of organic compounds increases by leaps and bounds, but the number of silicates is comparatively small.

Q. I didn't mean to say the same number, but the same progress has been made in research in silicates, but not to the same degree?

A. I don't know how much progress has been made in silicates.

Q. You have no idea how many silicates there are of that type, in contradistinction to naturally occurring silicates that there are known to chemists?

846 A. I have no idea.

Q. There might be a thousand?

A. I wouldn't want to even make a guess.

Q. You would say there are 500?

A. I wouldn't say there were 500. I just don't know.

Q. Do you know whether all of them can be used? I am speaking now of metallic silicates more particularly, in the composition of the patent in suit.

A. Assuming that there were 500, as you said a moment ago, the question is, could that 500 be used?

Q. Yes.

The Witness: I do not think that they could all be used, no, sir.

By Mr. Oberlin:

Q. Even if you added calcium fluoride in the amount called for by the patent?

A. Yes, because the other constituents might not be correct.

847 Q. As the patent says, and as we notice at the outset of this examination, the composition is of the utmost importance, is it not?

A. Oh, yes, certainly.

Q. All right. In addition to metallic silicates, there are what we call organic silicates, are there not?

A. Yes, sir, there are organic silicates. They are sometimes—that is, there is an ethyl silicate; I am familiar with that. It is a liquid.

Q. A well known compound?

A. Yes, fairly well known.

Q. What is its physical character; it is a liquid, did you say?

A. Yes, sir.

Q. A mobile liquid?

A. Yes, fairly mobile.

Q. Well, could it be used in the composition of the patent in suit?

A. Oh, no, because it is volatile, and it would not be of any use at all, at a high temperature.

It vaporizes readily.

Q. Could it be used if you added up to 8 per cent of 848 alumina?

A. Well, adding 8 per cent alumina would just simply be mixing a powder with a liquid.

Q. And it still would not work?

A. Oh, no, of course not, because it would be just like stirring up alumina with water here.

Q. But that would be a composition which contained, or comprised, a silicate, with one to eight per cent of alumina, would it not?

A. No, sir, it would not, because the alumina is not combined. It is just merely mechanically mixed in.

Q. I was not asking you about any combination. I said, that would be a composition which comprised it, would it not?

A. Oh, no, that would not be the same thing at all.

Q. That would be a composition in which there was a silicate, would it not?

A. Well, yes, sir, there is a silicate there, an organic silicate.

Q. And if we only added one to 8 per cent, that silicate would constitute the main part of the composition, would it not?

A. Well, I suppose it could constitute the main
849 part, if you started with that.

Q. And the balance would be the one to eight per cent of alumina.

A. Yes, but they are not combined; they are not the same thing at all.

Q. I did not ask you anything about whether or not they were combined. I asked you—

A. It would merely be a mechanical mixture.

Q. But the composition would comprise that, would it not?

A. Oh, not in the sense in which it is used here, no, sir. We are dealing with a volatile liquid here. I think it is absurd to consider a thing like that.

Q. A known metallic silicate is ferric silicate; is that correct?

A. Yes, sir, ferric silicate is known; and I might say that the composition you mentioned a moment ago, is not a metallic silicate, of course.

Q. I was not asking you about metallic silicates, Doctor. We were confining the examination simply to silicates. I am sure that there is no confusion in the record with respect to that.

850 The Witness: Possibly not.

Mr. Oberlin: I certainly did not intend to confuse it.

By Mr. Oberlin:

Q. I am asking you now about ferric silicate.

A. Yes, sir, I think that ferric silicates are known, probably.

Q. Will a ferric silicate work, or serve the purpose, in the patent in suit?

A. I think that, in the case of ferric silicate, the iron is combined with the silica, and I imagine that one could use a ferric silicate—although I have not tried this, and my answer is therefore speculative; but I believe that one could use a ferric silicate, with the other suitable ingredients, to make a welding composition.

Q. Would you stake your professional reputation on that, without making a test, Doctor—

A. No.

Q. —or experiments?

A. No, sir. As I said, that is speculative.

Q. In other words, it would call for a further experiment, or determination, or test would it not?

A. Well—

851 Q. (Continuing.) Before you would know whether or not ferric silicate could be used in the composition of the patent in suit?

A. I would think that it could be used, but I think if I were going to use it, I certainly would try it.

Q. But you would not recommend it to your client here, the Linde Air Products Company, without first having such a test of it made, would you, Doctor?

A. Oh, I think that it might be possible to do it, all right, but I suppose, as a matter of precaution, one would want to try it first.

Q. How about strontium silicate? I will ask you the same question as to its utility.

A. I think that strontium silicate would be satisfactory.

Q. You have never tried it, however, have you, in attempting to make the composition as called for by the patent in suit?

A. No, sir, I have not myself tried it.

Q. Would you stake your professional reputation on its being useful, in making the composition called for by the patent in suit?

A. Yes, sir, I believe that I would, in this case, because strontium, in its properties, is midway between calcium
852 and barium, and calcium and barium work all right, and I would certainly be sure that strontium would.

853 Q. Of course, strontium is an alkaline earth metal, is it not?

A. Yes, although it is not included in the patent.

Q. The patent does not mention strontium, does it?

A. No. It does not mention strontium.

Q. How about barium silicate? The patent does mention barium silicate?

A. Yes.

Q. Will it work?

A. Yes. I think Mr. Kennedy testified barium silicate worked.

Q. As I remember, he testified both ways, but I am asking you about your own opinion, not quoting Mr. Kennedy, please.

Q. I am asking you, Doctor, not to refer to other
854 testimony. I am asking you for your own knowledge on the subject.

A. Of course, having heard that testimony, I cannot

help but be convinced it would work. If Mr. Kennedy tried it and says it worked, I believe him. I think he is truthful.

Q. You will stake your professional reputation again?

A. I would, yes.

Q. Now, by whether it will work, we mean that you substitute it for calcium silicate in a composition such as is shown in this table at the bottom of column 2, page 2, just so we may understand each other?

A. Yes. It would probably be, then, barium silicate with these other additions, calcium fluoride, aluminum, and so forth.

Q. You have never tried it?

A. No. I have not tried it myself.

Q. I think you stated in the course of your testimony this morning what clay was.

A. Yes.

Q. Will you repeat the definition, to refresh my recollection.

855 A. Clay is primarily an aluminum silicate containing some combined water and has impurities in it, a small amount—well, I do not know whether they are impurities, because they always occur in it—I would say small amounts of calcium, magnesium, iron, titanium, sometimes potassium and sodium.

Q. They are not present as such, of course?

A. No, no.

Q. In what form are they present?

A. I am referring to the oxides of these elements now.

Q. Are they there as oxides or are they also in the form of a complex silicate?

A. They are probably more in the form of a complex silicate. If we would analyze them, we would report them as oxides.

Q. In the matter of analyzing or reporting the analysis as you discussed this morning?

A. Yes.

Q. That would indicate that what you have there is a complex silicate?

A. Yes.

Q. The metals are aluminum, calcium and magnesium and possibly some iron in the others?

856 A. Yes, combined with silica.

Q. So clay is a silicate?

A. That is right.

Q. A metallic silicate?

A. Yes.

Q. Doctor, have you—

A. It is a peculiar type of silicate, though.

Q. Have you noted the analysis given, the purported analysis given on page 1 of the patent in suit, in the second column, beginning with line 35?

A. May I have that reference again, please?

Q. Page 1 of the patent in suit.

A. Yes.

Q. Beginning at line 35 of column 2.

A. I have it.

Q. Have you noted that analysis?

A. Yes. I have noted that analysis.

Q. That purports to be an analysis of a natural clay, I believe.

A. That is right.

Q. Is that an unusual analysis?

A. Well, it is not entirely a clay. It is an analysis of a flux.

Q. Oh, yes.

A. To that clay had been added some ferromanganese.

857 Q. That is not stated in this description, is it?

A. No. I think it is somewhere here, though.

Q. Is it?

A. Well, I understand it to be that, because the manganese is not reported as an oxide, and the iron is reported as an element, and I assumed that that meant they were added in the metallic form there. That was my understanding of it.

Q. Well, the assumption is that these oxides and their, as you say, two ingredients indicated as metallic elements not combined with oxygen, manganese and iron—

A. That was my understanding of it, yes.

Q. —represents a natural clay to which ferromanganese has been added, is that your understanding?

A. Yes.

Q. Did you derive that from the analysis, or how did you derive that understanding?

A. Well, I think the first part of it is derived from the analysis—well, the whole thing.

Q. I mean, your understanding.

A. My understanding is derived from the analysis, yes. That is, not the complete analysis. I think there is usually some water present.

858 Q. In other words, that does not total up nearly to 100 per cent, does it?

A. I do not think so, no.

Q. So if there is clay as one of the constituents of this composition—and this was a welding composition, is that correct?

A. That is right.

Q. (Continuing)—if clay is one of them, that clay was a compound of these oxides? That is, the oxides were not there as such?

A. That is right. A compound.

Q. Now, you say—

A. Pardon me, just a minute. I am not sure whether all those constituents there were existent in the clay or whether perhaps calcium oxide may have been added to it. Maybe the ferric oxide had been added. I know they could be in clay, but I am not certain that they existed in the clay, and that some additional ones might not have been added as such.

Q. When you have a list of oxides, metallic oxides, given in an analysis or a purported analysis, you cannot always be sure that they are combined in the form of a silicate after all, can you?

A. No. You would have to know the nature of the
859 material. You could give an analysis of a mechanical mixture, of course if you wanted to.

Q. You are not sure, then, whether this lime was present as part of the clay or whether it was added in this analysis on page 1 of the patent?

A. I am very sure that the manganese and iron were added, and I am not certain about the calcium which could be present in the clay entirely.

Q. Such clays are known?

A. Oh, yes.

Q. Is aluminum an alkaline earth metal, Doctor?

A. No. I would not consider aluminum an alkaline earth metal.

Q. Why not?

A. Well, it does not have the same basic properties. It is an extremely weak base. It can also act as an acidic element, and therefore is not similar to any of the alkaline earth metals in that respect, and has a valence of 3, whereas alkaline earths have a valence of 2.

Q. Which of those reasons—

A. You see—pardon me.

Q. Pardon me. Which of those reasons just given in the case of aluminum would not apply to manganese?

860 A. Well—

Q. Manganese is a weak base, at best, is it not?

A. Well, it is strong enough to be called an alkaline material.

Q. At the best it forms a weak base just like aluminum?

A. No, no, no. It is much stronger than aluminum.

Q. Very well. It has different valences which are represented by the different oxide forms, does it not?

A. Yes, with properties totally different in these different valences; but I mentioned in my testimony it could have a valence as high as 7, in which case it forms a purple liquid which is an oxide, Mn_2O_7, which is very, very different from anything we have seen.

Q. That is a striking and distinguishing characteristic of that element, is it not?

A. Yes.

Q. As compared with calcium?

A. Yes. Calcium has only one valence. Manganese can have several. The similarity with calcium comes when it has a valence of 2, as in these cases here.

Q. Oxygen has a valence of 2, has it not?

A. That is right.

861 Q. Is there any similarity between oxygen and calcium, just because of the similarity in valence?

A. No, not a similarity because of valence alone. Where an element has two valences and shows totally different properties and different valences, then you are more likely to get similarity when the valences are the same.

Q. Do you know anything about the composition of cupola slag which has been mentioned in earlier testimony as a fluxing ingredient in welding, electric welding, arc welding?

A. I do not know exactly what the composition is. I know in a general way it is a calcium silicate, probably, with some magnesium in it and possibly other elements. I do not know the exact composition of that.

Q. Well, it is primarily a metallic silicate or a compound of metallic silicates?

A. Yes. It is a metallic silicate with a great number of impurities in it, of course.

Q. It is a completely, or substantially completely reacted composition, is it not?

A. I do not know whether it is completely reacted

or not. It has been fused, of course, or it would not
862 be a slag; but whether it is completely reacted or not, I would not like to state. I think it would depend on the conditions that existed at the time of its formation.

Q. Well, it is formed at a very high temperature, and as you say the ingredients that enter into it have been fused together, is that correct?

A. That is correct.

Q. You were excluding completely, and you were exercising the usual chemist's caution, were you not, as to there being possibly some unreacted minor quantities?

A. Yes. As you said, I would not want to stake my professional reputation on the fact it was completely reacted.

863 Q. Are you familiar with Bessemer slag?

A. Not very much, no. I know in a vague sort of a way what it is, but I would not be familiar with it, I do not think, very much.

Q. Would your knowledge extend to confirming the statement that it is likewise a metallic silicate or a combination of metallic silicates?

A. I think it consists largely of metallic silicates, yes.

Q. And the ingredients that entered into the composition that were interfused had a high temperature in the process?

A. Yes. I think it certainly has been fused.

Q. Well, at the temperature that is found in the Bessemer furnace?

A. Yes.

Q. And in that furnace steel is rendered molten, is it not?

A. That is right.

Q. So that the flux has been—this material has been submitted to a temperature at least that hot?

A. That is right.

Q. In the case of open hearth slags, both acid and basic, are you familiar with that?

864 A. No, I am not very familiar with the exact composition of those materials.

Q. Does your knowledge extend to enable you to confirm the fact that they likewise are metallic silicates?

A. I think probably they do contain silicates, yes.

Q. In major amounts?

A. I would imagine so; I am not absolutely certain of that.

Q. They likewise have been subjected to very high temperature, sufficient to interfuse the ingredients?

A. Yes; they are heated.

Q. The temperature in an open hearth furnace, where they were making these slags was high enough to melt steel?

A. Yes.

Q. In the case of the cupola furnace which you have been talking about, was that a cupola furnace in contradistinction with the other furnaces we have been asking about?

A. My conception of a cupola furnace is one used for melting steel.

Q. So likewise their flux, this so-called cupola slag,
865 was subjected to a temperature at least high enough to melt steel?

A. Yes.

Q. Now, the table that we have discussed before, at the bottom of column 2, page 2 of the patent, does not include manganese or manganese oxide, does it?

A. No. It is not in that table.

Q. And that is the only place in the patent where precise percentages of the ingredients that enter into this patent composition are given, is that not correct?

A. No, I don't think so. I think that when he says here you can substitute one part for another, in stoichiometric proportions, I would say that was a very exact statement.

Q. Does he make that statement with respect to manganese oxide, Doctor?

A. He makes the statement particularly with a suggestion of magnesia.

Q. I am asking as to manganese oxide.

Mr. Cahill: Let him finish his answer.

The Witness: Any chemist would know it could be applied equally well to a chemical like manganese.

866 Mr. Oberlin: I ask that the question be answered, and move to strike the answer.

The Court: Read it.

The Witness: May I have the question?

(The question was read.)

The Witness: No, the statement is made with respect to magnesia, but that is not a complete answer, I don't think.

By Mr. Oberlin:

Q. Doctor, there is a reference made to the inclusion, in this composition, of manganese oxide, in the next paragraph from which you have just quoted, is there not?

A. Yes.

Q. All right. What does it say there?

A. It says, "Basic materials other than lime or magnesia, for example oxides of manganese," and so forth.

Q. Yes. And how may they be combined, in what amounts, according to the teaching of the patent, referring now to manganese oxide specifically?

A. Well, it does not give any exact amount there.

Q. It says in what amount, does it not?

A. No, sir. It just says:

867 "* * * borax or boric acid may be added in moderate amounts."

It does not say that the others can be. It says:

"* * * and known fluxing agents such as borax or boric acid, may be added in moderate amounts."

I do not think that the language "moderate amounts" applies to the preceding elements.

Q. You do not?

A. That is not the way in which I interpreted it when I read it over, no, sir.

Q. Will you name the alkali metal oxides, familiarly known to the chemists?

A. Well, the alkali metal oxides, the common ones, are oxides of potassium, sodium, and lithium.

Q. They are included, then, under the list of basic materials to which you have just referred, in the second paragraph, column 2, page 2 of the patent; is that correct?

A. Yes, sir, they are included there.

Q. And can they be substituted in stoichiometric relation to the other ingredients—silica?

A. That I do not know; I have never had any
868 experience with a composition like that.

Q. But you say that manganese can be, under the teaching of the patent?

A. Yes, sir.

Q. You do not know, however, whether the alkali metals, similarly substituted for calcium oxide, will work, do you?

A. No.

Q. You only know that manganese oxide, thus substituted, will work, because you have seen the flux here in

evidence, which you understand does work as a welding composition; is that not correct?

A. Yes, sir.

Q. But as to an alkali metal oxide, similarly substituted in the formula of this patent, you do not know whether that will work or not, do you?

A. No.

Q. Do you know that alkali metal silicates have been used in the composition of fluxes employed in arc-welding, for many years past?

A. I believe that they have been so used, yes, sir.

Q. Have you had any contact with arc-welding other than in connection with your present study, in preparation for your testimony here?

869 A. No, no; I have had very little experience along that line.

Q. You are not an expert in that field?

A. I am not an expert in that particular field, no, sir.

Q. And you do not know what compositions have been used, then, as fluxing materials, throughout the years since arc-welding and electric welding have been practiced commercially?

A. No, sir, I could not give you anything on the composition of those fluxes.

Q. I did not expect that you could.

A. No.

Q. And I was just merely asking, to confirm my impression.

A. That is correct.

Q. By the way, Doctor, the patent also refers to—or contains the statement on page 2 that the patentees "have also used * * * various titano-silicates."

A. Yes.

Q. Do you find that reference?

A. Yes, sir, I find where it says:

"We have also used calcium titanate and various 870 titano-silicates, these being used when it is desired to introduce titanium into the weld metal."

Q. Could calcium titanate be substituted in stoichiometric relation to the silica, in the formula given at the bottom of the second column on page 2?

A. Well, I do not think that that would be a very good thing to do, because you would introduce too much titanium into your weld metal.

I think that one probably would want to design his composition in accordance with how much titanium he wanted to introduce into the weld metal.

Q. Your answer, then, I take it, is "No", is that correct?

A. I do not know whether it could be used in this proportion or not, but I say, if it were, you would get a great deal of titanium into the metal, probably.

872 Q. Dr. Willard, we were discussing that formula on page 1, Column 2, of the patent, I believe—

A. Yes.

Q. —just before the recess.

A. Yes, sir.

Q. Now, that purports—at least, it is so stated in the patent, to represent an old and well known flux, at the time the patentees began their work; that is correct, is it not?

By Mr. Oberlin:

Q. As a matter of fact, since you have been attending previous sessions of this proceeding, from the testimony which has been given, that is supposed to represent a flux which was used at Western Pipe and Steel Company back in 1932, and previously, perhaps; is that correct?

873 A. I understand that the testimony has been to that effect, yes, sir.

Q. Now, one of those ingredients, Dr. Willard, is alumina, represented by the formula Al_2O_3.

A. Yes.

Q. That is the identical material represented on your chart here, Plaintiff's Exhibit No. 193, in the fourth bottle, or vial in the second tier of specimens; is that correct?

A. Yes, sir.

Q. In other words, that represents this material in this old flux—or in those old fluxes, just as much as it does any ingredient in the fluxes involved in this suit, directly involved, does it not?

A. It is the same material.

Q. Identical.

A. The same, yes, sir.

874 Q. And another such ingredient is lime or calcium oxide, represented in this formula by CaO, is that correct?

A. That is correct.

Q. And that is the identical material that you have just illustrated in the first vial in the tier of bottles just referred to?

A. That is calcium oxide.

Q. And another such ingredient found in this formula is silica, represented by the formula SiO_2 in the place in question, and that is identical with what you would call the acid constituent on this chart represented by the fifth bottle or vial?

A. That is right.

Q. And those are identically the same constituents that are found in the table of analyses, representative analyses, at the bottom of column 2 of page 2 of the patent, as representing the patentees' welding compositions which have been found successful, is that correct?

A. Well, I find more than that in this formula here. I find manganese and iron also.

Q. I am referring to the little chart or table at the bottom of column 2, page 2 of the patent.

875 A. Yes; but there is no manganese in that.

Q. I am not asking that. I am asking if the ingredients you have just identified on this chart as representing ingredients found in this formula on page 1, are the same ingredients as are also found in the table at the bottom of column 2, page 2?

A. My answer is that if you refer to the incomplete designation, they are the same. But you haven't listed all that are given in lines 36 to 38.

Q. In the table on page 2, column 2, representing welding compositions which have been successfully used by the patentees, so they say, there is lime represented by the formula CaO and by the first bottle in this tier on the chart?

A. That is right.

Q. And that is the same ingredient that is represented as present in this old flux by the same material on page 1?

A. Yes.

Q. And the same is true of the ingredient silica represented by the formula SiO_2?

A. Yes.

Q. That is present in both the flux on page 2 and on page 1?

876 A. Yes.

Q. And the same is true of the alumina represented by the formula Al_2O_3?

A. Yes.

Q. Those are identically the same ingredients in both

of these fluxes, therefore? I am not saying they are all in either, but I say they are the same as far as we have gone?

A. Oh, to that limited extent, they are the same; but not in the proportions the same.

Q. Now, you mentioned that in the formula on page 1, representing this old flux, there is found some iron, as such, and manganese as such indicated.

A. Yes.

Q. And that, you would assume, represents ferromanganese?

A. That is the way I understood.

Q. Now, is the addition of ferromanganese to the composition of the patent, the one which the patentees would teach the world, is the addition of ferromanganese to that flux precluded, or is it suggested even in the patent?

A. It is permitted I suppose you refer now to line—

Q. 45 and following, on the second column of page 2.

877 A. Yes, ferromanganese is permitted when one wishes to introduce some of this material into the weld.

Q. So that the addition of that in this older formula does not distinguish it from the formula given at the bottom of page 2 of the patent as the patentees' formula, does it?

A. I think it does, yes. It appears to me, in reading that paragraph—it says that it is possible and may at times be desirable to include this, but I do not think that analysis at the bottom of the page there suggested at all certain special cases. The patent says it can be done if you want to accomplish a certain result.

Mr. Oberlin: I think we are in agreement, Doctor.

By Mr. Oberlin:

Q. That is, the analysis given down there, as far as the ingredients pointed out, they are identical in both formulas, and while the formula on page 1 includes ferromanganese and it is not shown on this table at the bottom of the page, the addition of ferromanganese is suggested to this composition in the table at the bottom of page 2 by the patentees themselves is it not?

878 A. The addition of ferromanganese can be added on occasion.

Q. If they were added, then they would appear in the analysis, would they not?

A. If you had a complete analysis they would, yes. Of course, the propositions here are entirely different.

Q. How different are they?

A. You have 18—

Q. Will you take them up in order.

A. You have—

Q. Take the first ingredient that you find there, a common one to the two formulas. Take lime, CaO, calcium oxide.

A. Yes.

Q. In the old formula that was how many per cent?

A. That was about 6—that was 6 per cent.

Q. And in the new formula, the patentees' formula? Take an average.

A. 29½ per cent.

Q. Well, that is the first one, but that is approximately—

A. Well, there is some in which it is still higher.

Q. Very well. Take the alumina and compare them.

879 A. The alumina here is high, 18.86 per cent, whereas in formula No. 1 it is only 5.4 per cent.

Q. What merit is there in limiting the amount of alumina to 8 per cent, as you stated, from the teaching of the patent, rather than carrying it up to 18 per cent? Is there any, that you know of?

A. I do not know just what the purpose of limiting it is. I know that it has an effect which was undesirable, but I do not know exactly what it was.

Q. Do you know whether the flux would work just as well as that of the patent, if the alumina were, say, 10 per cent instead of 8 per cent?

A. I would believe it would not, or the patentees would not have limited themselves to 8 per cent if more would have produced the desired effect.

Q. You have no authority for that statement except the statement in the patent itself?

A. Yes.

Q. I mean, you have no knowledge otherwise?

A. No. I do not know, aside from the statement of the patent.

880 Q. Now, you recognize the ingredients of calcium carbonate and magnesium oxide and silica, referred to on page 2, column 2, line 51, and following, as ingredients used, or as materials used in the ceramic industries, do you?

A. Well, silica is certainly used in the ceramic industries, I am very sure about that.

I do not know just how, or to what extent, that calcium carbonate and magnesium oxide are used in the ceramic industries.

Q. Well, that is apparently where the patentees derived these materials, according to this statement that I referred to; that is correct, is it not?

A. I believe that it was testified that they got some impure calcium carbonate from a ceramic concern.

Q. Well, let us ignore that testimony. That is the implication of the statement that I refer to, in the patent itself, is it not?

A. I am not sure that I understand exactly what you mean.

Q. Well, the statement referred to previously in my examination was:

"The materials used"—

And the materials are the ones that I just identi-
881 fied.

"—were of the purest quality used in the ceramic industries."

A. Yes, that was the statement.

Q. But in those materials there was found, upon analysis, to be about 5 per cent of aluminum; that is also the statement of the patent, is it not?

A. That is also stated in the patent, yes, sir.

Q. So that in these commercial grades of supposedly pure materials there was that much alumina, nevertheless, present.

A. Well, there certainly was in this sample, according to the statement here, yes, sir.

Q. And was that present, would you assume, in the form of alumina itself, or as a silicate of alumina, perhaps, in which alumina would be one of the components?

A. Well, it does not say anything about the presence of any silica in here, so that I would not know.

Unless there were silica there, one could not answer your question. I do not know whether there was any silica in there or not.

Q. Would you be surprised to find 5 per cent of alumina present as an impurity in a commercial grade of
882 silica, such as might be used in the ceramics industries?

A. I would be rather surprised to find that much alumina in a commercial grade of silica, yes, sir.

Q. That comes pretty pure, does it not?

A. It can be obtained very pure. Certainly the glass industry uses silica of a very high grade of purity.

Q. How about the calcium carbonate; is that apt to contain that much alumina?

A. Well, that would depend upon the source from which the calcium carbonate was derived, I would say.

I do not think I can answer the question properly, when you say, "Is it likely"—or whatever the precise language of your question was. I just do not know whether it would be likely to or not.

I would say that ordinarily, if you asked for pure calcium carbonate, as a material of recognized purity, you would hardly expect to find 5 per cent of alumina in there.

Q. Well, evidently these patentees found, upon analysis, that from these three ingredient materials, namely, calcium carbonate, magnesium oxide and silica, there was included 5 per cent alumina?

883 A. In this particular sample, I think there is no doubt that is what they found.

Q. And the presence of alumina as an impurity in such materials, within such range at least, is to be expected, is that correct?

A. Well, you might have very small amounts of it. I think that is excessively high.

Q. You think that is rather high?

A. I wouldn't expect to find that much. I would expect to find more on the order of 1 per cent of that material.

Q. More on the order of the alumina you found present in the Defendant's accused composition, is that correct? I am referring to Chart Exhibit 194.

A. Let me see what those exhibit numbers are. That was 1.88 per cent.

Q. That would be within this range you would expect of impurity in the form of alumina, in commercial materials such as go into these compositions, would it not?

A. Well, that is pretty hard to say. I don't know whether one would expect to find that much or not. It would all depend on the specifications that you laid down in ordering this material.

884 I think it would be possible to get material that was low in alumina, if you asked for it.

Q. You mean lower than 1.88, but around 1 per cent?

A. I think it could be obtained still lower than that. Material—

Q. That is an assumption on your part. You have never made a check of such materials for the purpose of this suit or otherwise?

A. Well, I have analyzed many materials like limestone which contained much less than 1 per cent of aluminum oxide.

Q. And you have found them with more?

A. I don't recall at the moment whether I did or not. It is possible. And I have analyzed samples of magnesia that contained less than 1 per cent of aluminum oxide, and samples of silica that contained less than that.

Q. Actually the amount of alumina in this chart, Exhibit 194—and I am referring now to the colorful figure on the right center—is smaller than the amount you leave blank and assign to Miscellaneous, is that not correct?

A. It looks about the same size from here.

Q. What is the actual percentage as you have the 885 analysis available, or on the chart?

A. The sum of miscellaneous here would be about 1.59, I believe, for the miscellaneous.

Q. That miscellaneous represents, I believe you indicated in effect, impurities? That is, they were not essential constituents?

A. Well, not entirely so. Magnesium oxide makes up a considerable amount of that miscellaneous, and magnesium oxide certainly is not a detrimental constituent.

Barium oxide makes up a large part of it and that is not a detrimental constituent. I would say that those impurities were not only harmless, but they are included in the patent as permissible ingredients.

Q. Are you familiar, Doctor, with the periodic table of chemistry?

A. Yes.

Q. And the grouping of metals under that table?

A. Yes.

Q. You have spoken also of alkali metals, I believe, or alkali compounds during your testimony?

A. Yes.

Q. In which group do the alkali metals fall?

886 A. The alkali metals fall in Group 1.

Q. They, as you indicated, are very closely related to the alkaline earth metals about which we have been talking here?

A. No. I do not think so. I think there is a big differ-

ence between the alkalis and the alkaline earths, a big difference.

Q. They are both capable of forming strong bases, are they not?

A. That is true, yes. They have a different valence. The valence of the alkali metals is one and the valence of the alkaline earth metals is two, and the alkalis form soluble oxides whereas the alkaline earths form largely, more or less insoluble oxides. I think there is quite a difference there.

Q. With respect to the characteristic I mentioned, that is, a capacity to form strong bases, the two are closely related?

A. Oh, yes. They are both strong bases. The alkalis are stronger, however, than the alkaline earths.

Q. The two principal alkali metals are sodium and potassium; that is correct, is it not?

A. Those are the common ones, yes.

Q. You named as one of the principal alkaline earth
887 metals calcium, I believe, this morning.

A. That is the common one, I think, perhaps.

Q. Where in this table of elements, in what group does manganese fall?

A. Manganese falls in Group 7.

Q. That is, it is five groups, or six groups removed from Group 2?

A. Yes.

Q. There are five groups in between, or is it the sixth group following?

A. That I suppose is true. That is misleading, though.

Mr. Oberlin: The question has been answered. I object to any volunteered statement.

The Witness: I cannot answer that question without elaborating on it a little bit.

The Court: That may be brought out by your counsel, if you care to elaborate on it.

By Mr. Oberlin:

Q. The manganese oxide which you have found as a component in the Defendants 660 flux I think you have designated as having the formula MnO; that is, the mon oxide.

888 A. That is right.

Q. However, you have testified that manganese

oxide is capable of holding more oxygen than the single atom represented in that formula?

A. That is right.

Q. Two or three times that much oxygen, to put it not in terms of valence, but quantitatively?

A. Yes. It can hold considerably more than that.

Q. And when present in the final compound as a manganese silicate, that characteristic is still present, is it not?

A. To a very slight extent, yes.

Q. Now, that capacity in a compound to take on more oxygen we call a reducing action, do we not?

A. Let me understand just what you mean there again. I am not sure I understood you.

Q. Well, I am asking you—maybe you have a better term for it, I am not a chemist—If you can call such a compound as we have described capable of taking on more oxygen as a reducing compound?

A. Yes.

Q. And the action as a reducing action?

A. Yes. Strictly speaking I suppose you could, although to me, it is very difficult for me to imagine a 889 higher oxide of manganese as a reducing compound. I do not quite understand that.

Q. I am speaking of the compound in the form in which it is present in 660 flux. That is the lowest stage of oxidation.

A. Oh.

Q. Now, it is capable of taking on more oxygen. Its oxygen capacity is not fully satisfied in that compound, is it?

A. It can take on a little bit more, yes.

Q. When it does that, we speak of that as a reducing action?

A. Well, it takes on oxygen from the air—

Q. I do not care where it takes it on from. Please answer the question.

A. That is not the way I ordinarily think of a reducing action, however.

Q. Well, it has the capacity, as I have described it, has it not, this compound 660, with this manganese silicate as its principal component?

A. It has the capacity of taking up a little oxygen.

Q. Yes. Has calcium silicate any such capacity?

A. No.

Q. By the way, in the analysis of Defendants' 660
890 flux that you prepared and which is present of record as Plaintiff's Exhibit 197, I believe—do you have a copy of that?

A. It is on the chart here. I can use that just as well.

891 Q. Very well. You have allocated a certain amount, a certain quantity of oxygen among the various metals there, and you have presented, therefore, in your analysis, a number of oxides, have you not?

A. That is right.

Q. How did you determine that oxygen, in the first place, so that you knew you had that oxygen thus to allocate?

A. The analyst determines the element itself—the metal that is; and we know that calcium can only combine with oxygen in one proportion, so that there is no ambiguity about writing the formula for the oxide.

We know that there is oxygen there, and if it is combined with calcium, it can only be in one proportion.

Now, in the case of magnesium, the same is true; in the case of aluminum the same is true; and in the case of silica, the same is true.

In the case of iron, there are two possible oxides, but they can be distinguished by analysis, so that there is no difficulty on that score.

In the case of titanium, it could only be a higher
892 oxide here.

In the case of barium, there is only one possible oxide; so that there is no ambiguity there.

In the case of manganese, we have reported it as the amount noted; but we recognize also—at least I recognize that there is a slight excess of oxygen over that per cent, which then would be added on as what we call available oxygen.

Q. It may be present as one of the other oxides in part at least, may it not?

A. One might assume that it was, perhaps, Mn_2O_3.

Q. Yes. Now, in your analysis, you make no separate determination of oxygen at all, do you?

A. Well, I did not do that, no, sir; I did not in my analysis—I did not make any separate determination of the available oxygen.

Q. No; I mean of the total oxygen content in the original compound.

A. No, sir. One could not very well determine oxygen directly; that is not possible.

Q. Well, what you did was to determine the amount of each metal present, was it not?

A. Yes.

Q. And then you figured how much oxygen, if it
893 were in an oxidized state, it would carry?

A. Yes, sir, because we know that it is in an oxidized state.

Q. I am just asking you about the mechanics of your analysis, that is all.

A. Yes.

Q. That is the way you did it?

A. Yes, sir.

Q. So that you did not measure as such, in your analysis, calcium oxide, for example, did you?

A. Well, yes, sir, I did. As a matter of fact, I separated out the calcium from the mix, and I weighed it in the form of calcium oxide.

Q. You separated it out in the form of calcium oxide?

A. I weighed it in that form.

Q. I say, did you separate it out in that form?

A. No, sir, I separated it out as the oxalate, and converted it into the oxide, and weighed it as such.

Q. You then reconverted it to what you assumed was the form in which it was present.

A. Well—

Q. On the basis of your knowledge, which is extensive, is that correct?

A. It was not an assumption, no, sir. That is com-
894 mon analytical practice. Any analyst would do it that way.

Q. That is the procedure that the analyst would follow, but you did not separate out at any time from the original compound, calcium oxide as such, did you?

A. Do you mean by that, to crystallize it out, or something of that sort? No, I did not.

Q. However you might do it. You cannot do that, can you?

A. Oh, I do not think that you could just go and pick out calcium oxide, if that is what you mean, no, sir.

Q. What you did was to take or convert whatever calcium the individual metal was there into the oxalate?

A. That is the process of analysis, yes.

Q. That is not oxide, but oxalate?

A. Yes.

Q. And you separated that out by suitable means of separation?

A. Yes.

Q. And then you reacted on that with something else, and reduced it to oxide form?

A. But this is not a mechanical mixture. If this

895 were a mechanical mixture—

Q. I didn't say it was a mechanical mixture.

A. Calcium oxide has reacted with the silica and is no longer a calcium oxide but a silicate.

Q. I want to make it entirely clear to ourselves and to the Court that while we have been talking about these oxide ingredients, they are not actually in the silicate, which is the compound that constitutes the flux, either plaintiff's flux or defendants' flux. I think you have answered that sufficiently.

A. It is true it does not exist as oxide.

I think I explained to the Court earlier that when an oxide combines with a silica it forms a calcium silicate, such as a salt, and is no longer an oxide.

For example, if we combine chlorine, a gas, and sodium, a metal, we get common salt, which is not like either of the constituents.

Q. Similarly, a silicate is quite unlike any of the individual oxides which enter into it?

A. Yes.

Q. It is a distinct compound in itself?

A. Yes.

896 Q. Now, you have testified about determining the presence of calcium fluoride, I think, as such, in the defendants' flux compound 660.

A. That is right.

Q. Was all of the fluorine accounted for in that form? Can you say?

A. All I can say is that we found that some calcium fluoride existed as such in the flux. We identified the presence of that in the crystal.

Q. Yes; and to make that identification, what did you do with the original flux when you undertook to analyze it?

A. We melted it and allowed it to cool slowly.

Q. It was not in the form in which it was sold and used by the defendants, after you had crystallized it, was it?

A. When it was used it was in the molten form.

Q. I am referring to the granular material, not after it had been put in the welding machine, of course. You have stated that was an amorphous material?

A. Yes.

Q. No crystalline material?

A. Yes.

897 Q. What you did was remelt it?

A. Yes.

Q. Allowed it to cool slowly, and crystallized it?

A. Yes.

Q. Then, by your X-ray diffraction method—I will not go into that in detail—you were able to detect what you thought was calcium fluoride as such?

A. Yes.

Q. But you did not find it in the original amorphous granulated material, which is the material with which we are here concerned?

A. It was the same material, but it had been crystallized. We had added nothing or taken away nothing.

Q. Is that crystalline material usable as a flux under the teachings of the patent?

A. Not under the teachings of the patent.

Q. Then you changed this condition to find the calcium fluoride present, as such?

A. Changed its physical condition.

Q. Do you know whether the calcium fluoride was present in that amorphous material, as a result of your examination?

A. I can't say, as a result of the examination. I would say it was, but I don't know from any definite proof

898 we had.

Q. Would this X-ray diffraction anyhow show more than the presence of calcium and fluoride ions in your crystallines?

A. Perhaps not, but the index of refraction test certainly is independent of that. That would show it anyway.

Q. We have asked you about various ceramics, which you have identified generally as being metallic silicate compositions, and mixtures of various metallic silicates. I would ask you about electric furnace slag; are you familiar with that?

A. No, I don't think I am.

Mr. Oberlin: That is all.

Redirect Examination by Mr. Wolfe.

Q. Dr. Willard, you told me earlier that you had some corrections you wanted to make in your calculations on Exhibit 195. If we might have that, would you make them, please.

A. Yes. What I did here was to confuse per cent with pounds.

At the top I will insert the heading "For a 100-pound batch." Then it will read:

899 "For a 100 pound batch, disregarding the CaF_2, which is present in both compositions, and allowing for the 2.66 pounds CaO shown to be present in the 660 flux by analysis stoichiometric replacement of the CaO as shown below, gives an MnO equivalent of 49.66 pounds" instead of per cent.

Then in the calculation below, "CaO 29.5%" will be changed to "29½ pounds."

"Less CaO not replaced 2.66 pounds" instead of per cent.

"CaO replaced by MnO 26.84 pounds equivalent to 33.95 pounds MnO.

"MgO replaced by MnO 8.7 pounds equivalent to 15.31 pounds MnO.

"Total 49.26 pounds MnO."

I will insert a line there, "remainder."

In the first column of figures that will be 64.46 pounds. That is what is left out of 100 pounds.

In the second column, that will be again 64.46 pounds.

Then the total—I will cross out the next line, which begins "This 49.26%," and so forth,—cross that line

900 out and replace it by putting at the left the word "total", then "100 pounds" under the column of figures the first column of figures; and under the second column of figures, adding these two numbers together, 113.72 pounds.

Then adding an explanatory note at the bottom, "49.26 pounds of MnO"—that is the same figure I had originally, but I am referring to pounds now—"in a batch of 113.72 pounds is 43.32 per cent. This is not far from the 48.19 per cent found by analysis."

Q. Does that correction make any significant difference in the overall results?

A. No.

901 Q. Dr. Willard, when Mr. Oberlin was questioning you, you had something further you wanted to say about the periodic table. I believe that you said the reference to spacing was misleading or something of that kind. Will you state what you had in mind?

A. I am quoting from the book which I previously used, namely Smith's College Chemistry, and I am quoting from page 363 of that book. The heading is entitled "Defects in the Periodic System."

"The periodic system is often described as if it furnished a classification of the properties of chemical substances which was complete in its scope, and ideal in its exactness. This, however, is far from being the case.

"The order of activity of the metals (p. 240) and of the non-metals (p. 284) summarizes many properties and explains many features of the chemical behavior of the elements. This list is scattered through the periodic table (compare both), without any trace of regularity.

"The periodic system concentrates attention too
902 largely on"—these are italics—"—one of the valences of each element."

That is the end of the italics.

"Thus, for manganese, it focuses attention on the septivalent form in the permanganates. But manganous salts are more like the ferrous, the cobaltous, the chromous, and other sets of salts, none of which are in the same column of the table. Similarly, the manganic salts are like the ferric salts and the salts of aluminum."

I will skip a few lines here dealing with copper and silver which are not important.

"In other words, the periodic system largely ignores the variety of different classes of chemical relations which an element with several valences always shows."

I would like also to read a few lines from General Inorganic Chemistry by Paul C. Freer. This is a text which we once used at the University. I am reading from page 459 down towards the bottom of the page: —

"The lower oxides of manganese, on the other hand, bear no resemblance to the halegon oxides." I might
903 say that the halegon oxides are in this same group 7.

"In fact, their nearest prototypes are to be found among the oxides of iron, chromium, cobalt, nickel or lead, while in many respects MnO acts very much like the oxides of calcium, magnesium, or zinc."

Q. Do you agree, Doctor, with the authorities from which you have just read to us here?

A. Yes, sir, I do agree that manganese, in a valence of 2, shows none of the properties which are characteristic of the elements of group 7.

Those are acid properties, and MnO is a basic material: MnO—or I mean, manganese with a valence of 7, is a strong acid; and MnO with a valence of 2, is a base.

They are just as far apart as could be.

Mr. Wolfe: If the Court please, I offer in evidence at this time the two charts which Dr. Willard has used, and which were previously marked for identification as Plaintiff's Exhibits Nos. 193 and 194.

904 Mr. Oberlin: We assume that these are merely offered as illustrative of the testimony of the witness.

Mr. Wolfe: That is correct.

Mr. Oberlin: With that understanding, there is no objection.

The Court: Admitted.

(Whereupon said charts, PLAINTIFF'S EXHIBITS Nos. 193 and 194 were admitted in evidence.)

Mr. Wolfe: I have no further questions of Dr. Willard.

The Court: Is that all?

Mr. Wolfe: Does counsel have any further questions?

The Court: While we are waiting, there is just one question that I would like to ask you, Doctor.

You gave some testimony regarding the chemical composition of the clay flux described on page 1 of the patent in suit, and there was also some testimony with respect to the similarity of the composition of the flux, and the flux described on page 2.

905 Now, this question occurs to me: If you found a clay which had certain properties in it, similar to this flux which is described on page 1 of the patent, or if you did not have some of the elements that are in the composition of the flux described on page 2,—that is, one of those four there, in the chart on page 2, one of those five,—could you, by taking that clay, if it contained all of them, or, if it did not, adding what other elements were lacking to make up those that are contained on page 2, in the chart, prefuse that clay, with or without the addition of the other elements, or oxides, and get something similar to the composition described on page 2.

The Witness: I am sorry, your Honor, but I am not sure that I just understand that question.

The Court: In other words, can you pre-fuse the clay, and pre-fuse it itself, or with something in addition, that is, some oxide in addition?

The Witness: Well, if you used the clay as a source
906 of, say, aluminum and silica, and calcium, and so forth—is that what you mean?

The Court: Yes.

The Witness: If you fused it—adding whatever necessary materials were needed to bring it up to the right composition, that is?

The Court: Yes.

The Witness: And then you fused it?

The Court: Yes.

The Witness: I do not think that it makes very much difference, your Honor, what the source of the materials is; if you have got silica, and aluminum, and calcium, and these other elements in the right proportions in your raw material, and if, then, you fuse them as directed in the patent, I think you would come out with the same product.

The Court: In other words, what I am trying to find out is this: what happens to the clay if you put it in an electric furnace?

The Witness: Oh, well, clay has combined water in it, and when you fuse it in an electric furnace, you drive
907 off all of that water, so what you get there is aluminum silicate.

Now, there is not very much calcium in clay, so that you would have pretty much just an anhydrous fused aluminum silicate, which probably would not be a satisfactory flux, because the melting point might not be desirable.

If you mean, could you take the clay and add to it the necessary amount of lime, and so forth, using only the elements that happen to be in the clay as a source of silica, and so forth, then, with the amount of aluminum, which in the clay is pretty high, if your added enough other constituents to bring that down to the proper value, why, then I think that you should get a suitable flux.

908 The Court: Well, my primary question was, if you put clay as such in an electric furnace and heat it as you do these other elements in the patent, what happens? What do you get?

The Witness: You would get a fused aluminum silicate which would not be like these other materials here because it would be deficient in calcium, magnesium, manganese or

these bivalent metals because they are not very much present in clay; only to a minor extent. I do not think aluminum silicate as such would make a very good flux.

The Court: I think you have answered my question. Thank you.

909 ROBERT S. MILLER, called as a witness on behalf of the plaintiff, having been first duly sworn, testified as follows:

Direct Examination by Mr. Cahill.

Q. Will you give your address to the Court Reporter, Mr. Miller.

A. Portland, Oregon.

The Court: What is your first name again?

The Witness: Robert S.

By Mr. Cahill:

Q. What is your occupation, Mr. Miller?

A. I am president of the Pacific Chain & Manufacturing Company.

Q. What is the business of the Pacific Chain & Manufacturing Company?

A. We manufacture link chain, particularly anchor chain.

Q. By "anchor chain" there, you intend to signify chain for use in connection with ships?

A. Yes.

Q. How long have you been in the business of manufacturing chain?

910 A. About twenty-five years.

Q. When was the Pacific Chain & Manufacturing Company organized?

A. January, 1941.

Q. What is your position in the Pacific Chain & Manufacturing Company?

A. President.

Q. At the time of the organization of the Pacific Chain Company, were you engaged in a search for a different method of manufacturing anchor chain?

A. Yes.

Q. Will you tell the Court what you were looking for at that time?

A. Previous to the organization of the Pacific Chain I was experimenting, investigating to find a method by which we could economically weld high tensile steel to produce a chain that was required having a higher tensile strength than chain which had been used for hundreds of years, which were made out of wrought iron or real low carbon steel, which were the only steels or irons that could be fire-welded. High tensile steel cannot be fire-welded satisfactorily, and never has been, to my knowledge.

911 There was in existence at that time two other methods of making chain of high tensile steel, but I wanted a method by which I could make a high tensile steel out of round bar stock and weld it, realizing if I could get the right kind of a welding system to do that I could produce anchor chain at a lower cost than either of the two methods that were then in existence and had been in existence only for a few years, where welding was not used.

Q. Did you find such a method?

A. Yes. Before the Pacific Chain Company was organized in January, 1941, I was manager of another chain company; and for approximately two years previous to the organization of the Pacific Chain Company, I did considerable experimenting and investigating.

I looked into various methods of welding, including thermit. We determined that thermit would be a satisfactory method from the standpoint of making a good weld, but not from the standpoint of cost.

Then during 1940, we started experimenting with the Jones patent method of welding, as it applied to our particular welding job.

912 Q. And did you thereafter adopt and employ the Unionmelt system of welding in the operations of the Pacific Chain Company?

A. Yes.

Q. And for what purpose was the Pacific Chain Company organized in 1941?

A. For the purpose of making high tensile steel chain by this method.

Q. Now, in 1941, can you tell us whether or not anchor chain was plentiful?

A. It was not plentiful in 1941, particularly in the latter part of 1941.

Q. Can you tell us whether or not there was any de-

lay of new ships being built in connection with lack of anchor chain?

A. Yes. That occurred, however, first in 1942. We were told by the government at one particular time that there were 19 liberty ships ready to be delivered but were being held up for the lack of one thing, and that was anchor chain.

Q. How many chains, how many anchor chains or how many suits of anchor chains, I believe they call it, does a ship ordinarily carry?

A. They have one suit. That consists of twenty 90
913 foot sections, or 1800 feet.

Q. And was it necessary, in the early years of the war, for some of the ships to go out with less than a full suit of anchor chain?

A. Yes.

Q. Now, on what percentage of the production of Pacific Chain Company did you employ the Unionmelt process?

A. At least 99 per cent.

Q. And how much chain did the Pacific Chain Company produce in its own plant during the three years following its organization?

A. Approximately $15,000,000 in sales value.

Q. Now, how much does the average chain equipment for a single ship cost?

A. The average would be approximately $6,000.

915 Q. So that the Pacific Chain Company supplied chain by this process for how many ships, Mr. Miller?

A. Approximately 2500 ships.

Q. Now, in addition to the productivity of the factory of the Pacific Chain Company by this process, can you tell us whether or not the Pacific Chain Company engineered the identical product for other concerns during the war?

916 A. Yes.

Q. And by the same process?

A. Yes.

Q. Now, what percentage of the production of anchor chain for the war purposes did the Pacific Company itself produce?

A. Approximately 25 per cent of the anchor chain — rather, the high tensile anchor chain used on all medium and large-sized vessels.

Q. Will you describe briefly to the Court the nature of making anchor chain, from what you have termed earlier, bar stock?

A. We obtained the rolled bar stock from the mill in long lengths, sheared it to predetermined lengths, and formed them into the links of the dimensions to meet the specifications as to length, width and so on.

In forming the straight bar into the link, there is a gap where the two ends meet at the side.

The chain is then taken to the welding machine, and the flux is contained in the split copper mold, in our application, and the rod fed into the flux, and forms the weld
917 to join the two ends of the bar to make a solid link.

Q. When you referred to the fire method of welding earlier, to what kind of welding were you referring?

A. Well, a simple blacksmith weld.

Q. Now, what agencies of the government contracted for this anchor chain, of which you have told us?

918 A. Navy Department, Maritime Commission, the Army Transport, and Lend Lease Agencies.

Q. Can you tell us whether or not there were tests of different anchor chains, in connection with its acceptance by the Navy, the Maritime Commission, the Army and Lend Lease Services?

A. Yes, in all cases. I don't recall one exception. All chains were required to be proof tested, every link.

Q. And what can you tell us as to whether the chains so made, as you have described, by Pacific Chain, passed those Governmental tests?

A. It met the tests. Any that didn't meet the tests wouldn't be accepted.

Q. Now, with respect to the cost of making chain by this process: what can you tell us in that regard?

A. Well, at the beginning of the war, and all through the war, we led the industry from the standpoint of low cost to the Government, not only in the prices that we made to the Government ourselves, but they gave us credit for influencing the price downward in at least part of the rest of the industry.

Although we had the lowest contracted price, we
919 also made what were termed excessive profits, which were returned to the Government, to further reduce the cost.

Q. What were you told if anything in connection with

renegotiation, by agencies of the Government in this regard?

A. The Price Adjustment Board told us that we were given credit for having the lowest price, and also for our influence on the price.

Q. Now will you direct your attention, please, Mr. Miller, to the matter of man hours.

What can you tell us with regard to the saving, if any, in man hours in the manufacture of this anchor chain by this process?

A. Well, that is almost one and the same with cost. In other words, we had the low price because we had a low cost, and we had the low cost because we had low labor requirements to manufacture chain by this method.

Q. I omitted to ask you, Mr. Miller: What was the diameter of the bar stock which you described to his Honor?

A. The average for the Pacific Chain Company would be about a 2-1 16-inch diameter bar.

920 Q. Can you estimate for us, Mr. Miller, the total savings in man hours in connection with the manufacture of this chain, by this process in the factory of the Pacific Chain Company?

A. Well, it would be a little bit difficult to do that, because of various other methods, and also depending on the matter of whether or not you wanted to go back to the source of the material.

But as far as the price was concerned, as nearly as we could estimate it, from what we were told by the Government, and what we knew about it from other sources, our costs must have been at least—well, ranging somewhere between 20 and 25 per cent less than the average for the other methods, which would be the same in labor saving, apparently.

Mr. Cahill: That is all.

Cross-Examination by Mr. Stewart.

Q. Mr. Miller, this was in 1940 that you started using the Unionmelt process, was it?

A. We started experimenting with it in 1940.

921 Q. Experimenting.

A. Yes.

Q. When did you first start to use it commercially?

A. In 1941.

Q. Your company executed a license agreement with the Linde Air Products Company, did it not?

A. Yes.

Q. And a rod purchase contract at the same time?

A. Yes.

925 Q. Now Mr. Miller at the time you executed the license agreement, were you told by representatives of the Linde Air Products Company that it was necessary to buy the weld rod, to be used under that license, from Linde?

A. I do not recall that they did.

926 Q. You do not recall?

A. If they did, I do not remember it now.

Q. But you executed at the same time you executed the license agreement, a contract for the purchase of all your requirements of weld rod—

A. Yes.

Q. —wasn't that correct?

A. (No answer.)

Q. Wasn't that correct, sir?

A. We buy all our welding rod from them, yes.

Q. You executed a contract to do that, to buy all your requirements of weld rod from Linde to be used in this process?

A. Well, as far as I knew we had no other source. Whether we had a contract or whether we were obliged by contract to buy all that rod from them, or whether we could go to some other source and buy it, I am really not certain.

927 Q. There were two contracts, were there not?

A. As I recall it.

Mr. Stewart: That is all.

Mr. Cahill: That is all.

WALTER TURNER FISHLEIGH, called as a witness on behalf of the plaintiff having been duly sworn, testified as follows:

Direct Examination by Mr. Wolfe.

Q. Will you please state your full name, age and residence, Mr. Fishleigh.

A. My name is Walter Turner Fishleigh. I am 66 years old. My residence is in Detroit, Michigan.

Q. What is your professional background?

A. Well, I was born and raised in Chicago and graduated from the Lake View High School in Chicago. I went to the University of Michigan and graduated there with an A.B. degree in 1902.

Following that for a couple of years I taught school, 928 in charge of the department of mathematics, at Battle Creek High School and saved enough money to go back and take engineering at the university. I went back and graduated with an engineering degree at the University of Michigan in 1906.

Upon graduation I was asked to remain on the engineering faculty and teach some subjects in preliminary engineering, and did so, remaining there as an instructor and later as an assistant professor.

In 1910 I asked for a leave of absence to get some practical experience and went with the Packard Motor Car Company in Detroit, Michigan, in their engineering department, first in charge of one of the design divisions and later in charge of the experimental test department of Packard which was charged with all experimental, laboratory and road testing of Packard automobiles and trucks. At that time Packard was manufacturing a three-ton truck as well as the pleasure car.

In 1913, returning at the close of my leave of absence, I went back to the university as an assistant professor and continued work for about a year, or a little less than a 929 year, in some of the fundamental courses in engineering as well as engineering mechanics and design. In the latter part of that year, however, I was given what I think of as being a very exceptional opportunity, that of establishing there at the university a complete course in automobile engineering, that course including design courses, electrical courses, laboratory and road test courses. That was the first complete automobile engineering course in this country or in the world. It was very interesting, because we had no chart, no anticipations and no prior art that we could follow.

In 1917, just after the outbreak of the first World War, I was called to Washington by the Council of National Defense and shown a situation in connection with the design and production of ambulance equipment, particularly, and motor transport in general, which was rather unfortunate due to the lack of experience of the army men, and asked to enter the army in charge of design and production

of, particularly, motor ambulance work at the start. I did so and entered the army as a major, and later was made a lieutenant colonel.

As part of that experience I was privileged, and I
930 put it that way because I think it was a privilege, to serve upon what was called the United States Motor Transport Standardization Board, a board of seven officers from the different corps of the army charged with the production, inspection and standardization of all motor equipment for the army, all motor transport of the army, that running from motorcycles to four-wheel drives, tractors and the like.

At the end of the war I returned to the University of Michigan with the rank of full professor, then in charge of the automobile engineering course, but in the summer of 1919 I resigned from the university to enter practical automobile work and went with the Ford Motor Company at Detroit, where for something a little less than eleven years I had executive charge, under the immediate direction of Mr. Henry Ford and Mr. Edsel Ford, of the various engineering activities of the Ford Company. That included design and experimental work and it ran from Ford cars to trucks to tractors and to a limited extent to airplane work.

931 In 1930 I left the Ford Motor Company and began what I had hoped to begin for some time, consulting work of my own; and since that time I have been engaged in consulting engineering work.

Q. Of what professional societies or the like are you a member?

A. Well, I have belonged for a good many years to the Society of Automotive Engineers. I have held some positions of trust in that organization. I have been on the Council several terms, the National Council. I was chosen as head of the Detroit Section of the Society of Automotive Engineers for a number of years—I should say for one year. Excuse me.

I belong to the Detroit Engineering Society. I am a member of Phi Beta Kappa, and Sigma Psi, and some other societies. I am a little bit embarrassed to have to say to your Honor that I never have received the Lincoln Gold Medal.

Q. Mr. Fishleigh, what experience have you had in connection with patents which would qualify you to explain to

the Court the elements of the claims here in issue and their application to the process and composition described
932 in the patent, as well as the Lincolnweld process and flux which are accused as infringements?

A. Well, my experience with patents began back when I was with Packard, where I had—that was 1910, 1911 and 1912—when I had to do with experimental development of a number of units which were patented and upon which patents were issued, such as carburetors, mufflers, injection starting systems and things along that general line.

When I got back to the industry in 1913 I did some consulting engineering work with some of my associates, testing and developmental work in connection with units which were either covered by patents or which they hoped to obtain patents upon.

During my war work, of course, I did very little with the matter of patents. We were too busy on other things. But when I went with the Ford Motor Company, they found out I had had some patent experience and I was more or less the mechanical goat whenever the legal department were up against new inventions and developments upon which they hoped to get patents, so I was more or less continuously—too continuously, really—engaged in patent work through my eleven years with the Ford Motor Company.

933 At that time I assisted in a number of patent suits in which the company was engaged. Since leaving the Ford Motor Company a very pleasant part of my work, my consulting work, has been the privilege of serving in patent suits now and then before the Federal Courts, attempting to advise the Courts upon mechanical and patent matters.

I have served a number of times in Chicago.

Q. Have you studied the patent in suit, and particularly the claims in issue and their elements?

A. Yes, sir. I have made a very careful study.

Q. Have you also studied the file wrapper and contents of the three applications which matured in the patent in suit?

A. Yes, sir, I have.

Q. Did you witness the demonstration of the Lincolnweld process which was conducted at the plant of the Defendant Graver Company in this case?

A. Yes, sir, I did.

Q. What familiarity do you have with the so-called

Unionmelt welding process, as it is practiced by the Plaintiff's licensees?

A. Well, within the last year and a half, I have
934 gone out of my road to familiarize myself with that process, first, because I found it a very fascinating process and, secondly, because I found it accurately exemplified the process of the patent.

I have witnessed and directed a great many tests of one kind or another on plates of one thickness and another.

I have also seen the process in operation commercially in other plants than the Plaintiff's plants. A great deal of the test work that your Honor heard Dr. Doan talk of, I also participated in and worked with him, to considerable lengths.

Q. Have you had any opportunity to observe the Lincolnweld process, except at the Graver plant demonstration?

A. The Lincolnweld process?

Q. Yes.

A. Yes, sir.

Q. Tell us about that.

A. Well, after seeing the Lincolnweld demonstration at the Graver plant, I was quite curious, and I felt that I wanted to know whether that was the way that process
935 was practiced commercially, as was stated to us at that time.

So I made arrangements to visit a number, specifically two, commercial plants where this process was being practiced. One of them was the—I have some notes which I made at the time; I want to get the name right—one was the Tecumseh Products Company at Tecumseh, Michigan. I went there particularly, because I was informed that there they were welding with the Lincolnweld equipment as well as with the Unionmelt equipment, but on thin plates, not as heavy plates as I had seen in the Graver demonstration.

I made a visit there on October 11th, 1946, and they were welding the housings for a large refrigerator pump. Those housings were about ten inches in diameter, more or less spherical, but not quite, but flanged up, made in two halves and flanged up, those two halves being abutted together then and assembled and the weld made circumferentially, the drum being rotated under the welding machine, the flux being fed down much as you have seen in

the demonstrations here, but the welding head remaining stationary, the drum itself being rotated.

The excess flux was picked up, of course, and it fell
936 off the drum as it rotated past the welding spot.

I made careful notes, particularly of the operation. I inspected the welds after they were finished. It was very interesting to me, because in this particular plant they were trying out—and I expect are today still, because it was going to be quite a try out—right in the same bay, within ten feet of one another, was one welding machine of Lincolnweld and another machine of Unionmelt; so right there I could make a very nice comparison of how they operated.

937 I think that I had mentioned the fact that at this plant it so happened that they had two setups, one for Lincolnweld, and one for Unionmelt, right in the same bay, and under the same supervision, although operated by different operators, within, say, ten feet of one another; so that it was an exceptionally good opportunity to see and compare the two processes.

Except for the fact that I knew that Lincolnweld flux was shaded a little bit differently in color, the two processes operated, and looked, and were identical.

The two processes operated on the two machines, but
938 the processes operated in the same general way, and produced the same welding results.

When the housings were inspected after welding, I could not tell one from the other. They were operated under substantially the same conditions, although not exactly; I have the detailed figures if you care to have them, but perhaps that is not necessary, on the voltages, current, and so forth.

I might also say that in that plant—I believe I mentioned this before—the material that was being welded was relatively thin, and there they were not using Unionmelt 20 but Unionmelt 90, which is the form of Unionmelt which has a major proportion of manganese silicate rather than calcium silicate.

Q. And there were some other places where you did see the Lincolnweld process in regular commercial use, I believe you said?

A. Yes, sir, but I thought perhaps it might be of interest to just check my own recollection, so that it would not be just a recollection. I have the original notes, which I made at the time.

Among other things, I say:

939 "No open arc; no glare; no spattering of molten material; no fireworks. Identical"—

Speaking of Unionmelt.

"—with Unionmelt 90.

"End of electrode completely enveloped in granular flux."

You will notice that I do not say "molten flux", because I could not see that at all. The operation was as your Honor saw the operation yesterday, of Lincolnweld, over in the shop there, where you could not tell, you could not see the molten flux under the granular flux on top.

I have details of the others, if someone wants to have them given.

Q. Now, as to these other places you visited.

A. Well, the other place was—one other place was up at Saginaw, Michigan.

The reason I went up there was I inquired around to find where the Lincolnweld process was being used on heavy plate, so that I would get the range. See, I thought perhaps it might be different on heavier plate, and particularly so because at that Grayer demonstration, if you will recall, the plates were much heavier than this I
940 have mentioned at the Tecumseh Products Company.

So I arranged to be taken up to the Saginaw plant. That plant was the Wicks Boiler Works. We met the general manager, Mr. Bintz, and arrangements were made so that we might see them weld with the Lincolnweld process and flux, at that plant.

I have a note here that the welding was being done—this was on November 11, 1946, at which time they were doing regular commercial welding on a large boiler made of one and one-sixteenths inch thick plate.

I was informed that the pressures which were required for that boiler were something of the order of 450 pounds per square inch, which is quite a pressure to withstand.

I have quite a bit of detail on the specific operation. It happened that they were welding with one preliminary pass on the outside of this drum—it was a circumferential weld here again, and in this case again just the reverse to what we have seen in the laboratory. Instead of the plates which were being welded being held stationary and the welding head moved along, just the reverse was
941 true.

A big drum or tank—I have a note that it was four feet in diameter and 18 feet long, a real large drum—the welder was on top of it with the welding machine set up on a crane, reaching over the center, and the pipe itself or the drum itself was rotated under; practically the same result as we have seen in the laboratory, only reversing the movement, the relative movement.

There again I watched them weld through a considerable time, on this welding. I asked the superintendent, who was a very congenial chap, whether this was representative of all their weldings, and he said yes; and I have notes here and recall very distinctly, because of the thickness of the plate being welded, that there was no spark, no fireworks, no throwing of molten material, no flame, no smoke.

It was practically the same operation as I saw down at the Tecumseh Products Company. Frankly, I was rather surprised, because that metal is pretty heavy, and there was something over 100 horsepower going through that weld all the time, and I expected to see more—some evidence.

I have a note here in my original notes: "No fire-
942 works; that is, no sparking, no flames, or smoke. No scattering or spattering of molten material. Electrode completely submerged in the flux burden."

I have a note here—and I think I failed to catch that note over at Tecumseh—that in neither case did the operators wear any goggles or protection.

943 I asked particularly in the heavy plate, where the current was heavy and the horsepower heavy, I asked the superintendent if he didn't think it would be best to have his men wear at least glasses; they needn't be colored glasses, but at least glasses, because you never know in welding where something might happen, as your Honor saw something happen in the welding yesterday, where something goes through and there is more or less of an explosion. And if I was the welder, I would wear clear glasses, just to protect my eyes in that case.

He told me, no, his boys never had, and as far as he was concerned, he thought there was no reason for them wearing any protection on their eyes.

Q. Returning to the Graver plant, aside from the demonstration you saw there, have you at any other time seen the Lincolnweld process in use there in any commercial production?

A. I stated a few minutes ago, after seeing the first demonstration at the Graver plant I was curious. After seeing these other two demonstrations, I was more curious; and I asked to have some arrangements made, if pos-
944 sible, so I could go into the Graver plant and see, actually see, their commercial production.

Perhaps I should say I was suspicious, but I don't like to use that word.

So arrangements were made, and on May 21st, 1946, I went through the Graver plant at East Chicago.

Q. Do you have that date right in May?

A. No. That is wrong. I have a note here that the original Graver tests were on May 21, 1946. I beg your pardon. On November 13th, 1946, arrangements were made and I went through the Graver plant and saw commercial welding going on there; not one operation, but two which happened to be going on, incidentally, in the same bay of the shop where our demonstration had previously been held, one of the operations being with the same welding crane.

One of the welds was being made on the exterior circumference of a large welding drum. I did not measure it, but roughly my estimate, and the estimate of the gentleman, Mr. Maver with whom I went through, was that it was on the order of ten feet in diameter, a very large drum.
945 They were circumferentially welding here something similar to the circumferential work I had seen at Saginaw, and here again the weld was being made on top with a crane overhanging and the drum being rotated underneath.

I have a note—well, I asked the operator what the amperage and voltage was because the registering meters were up on the crane with the operator, and the operator told me they were working with 600 amperes at 32 volts.

The plate was about half an inch thick, plus or minus.

I have a note here, "No fireworks at all in any way. No sparking, flames, et cetera. Perfectly quiet, unobtrusive operation."

I have another note, "The operator wore no eye protection of any kind." I may say that the operation was just practically the same as you saw yesterday with the Lincoln flux over here in the laboratory; practically the same as you saw here in the movies—that is, not the movies which were taken at the original demonstration given by

this Defendant at the Graver plant, because there you saw plenty of fireworks and sparking and throwing of
946 material. There was nothing of that sort, and this, mind you, was in the Graver plant itself.

Now, a little farther down the shop, in fact, back in just the position where the demonstration had been given, another welding process was going on. This was another drum similar to it. I have a note here that it was approximately 10 feet in diameter, but only—well, this time about 25 feet long, and I say the thickness of the plate was approximately one inch.

The welding at this time was being done on the inside of the pipe or drum, or whatever it was, a circumferential weld, but there was nothing in my road. I could look right in and see the operation because the welding head was going circumferentially, being down at the bottom, and you could see right in.

I have a note here that the operator again used no eye protection of any kind. I have a note, "A generally quiet operation without fireworks." I have here, however, a note, "with occasional unobjectionable sparking and a little flame", something as you saw over here on either
947 Unionmelt or Lincolnweld, where once in a while there is a little flame that comes up and possibly a spark, but a perfectly quiet operation different in kind, different entirely as a welding operation, as far as appearance was concerned, as far as these fireworks and all were concerned, to what I had been previously in what was told to us was the standard method of operation of the Lincolnweld process and with the Lincolnweld flux.

948 Q. Now, Mr. Fishleigh, I would like to turn to another matter. Just turn to the patent itself that is here in suit, please.

A. Yes, sir.

Q. I want to consider with you first the precise claims of the patent that are in issue.

I would like to have you explain to the Court as briefly as possible wherein the elements or steps of those claims are found in the welding process and composition that are described in the Jones, et al patent; and in doing so, you will please bear in mind, of course, the fact that Dr. Doan has described at length and in considerable detail the operation of the process, so that we will not want to be duplicating that kind of material in the record.

If you have any charts or diagrams that would shorten and clarify your answer, why, I would like to have you use them.

A. Well, I might say that, as your Honor no doubt knows from the pleadings, there are quite a few claims in suit.

I tried at the beginning to organize the claims in groups so as perhaps to save duplication, or unnecessary
949 explanation.

I had hoped, at the beginning, to be able to organize all of the process claims in just one group, perhaps, so that we could go right through those, and possibly one explanation on my part would suffice for all of them; and also perhaps organize the composition claims into just one group, so that we could run through those in the same manner.

However, as is often the case, there were variations between the claims, so that they did not fit together too well in one group. But I have still been able to combine them to a large extent, and if your Honor will bear with me while we discuss, perhaps, in each group, possibly just one claim, then at a glance your Honor can catch the differences in the other claims in that group; and that will save a great deal of time, and perhaps be just as good.

Therefore I will start with a couple of the claims, and I might say here why I start with that particular group.

I was able to group claims 8 and 9 nicely together, and I start with those, because they are perhaps as general, and give as much of an overall picture of the process as any of them.

950 I thought that, with a rather careful explanation of those claims, then when we come to other groups of the process claims, only a word or two on my part will perhaps make it clear,—unless your Honor has some other suggestion.

With that in mind, then, I will start with claims 8 and 9. I have, in order to save time, and perhaps to make my explanation a little more clear, photostatically made up a chart for those two claims.

Mr. Wolfe: I will ask at this time that the chart be marked as Plaintiff's Exhibit 199 for identification.

(Whereupon the said chart was marked Plaintiff's Exhibit 199 for identification.)

By Mr. Wolfe:

Q. Please proceed with your explanation.

A. On this chart, which has been marked for identification as Plaintiff's Exhibit No. 199, your Honor will note, at the righthand side of the chart,—and I will interrupt myself to say that, as I explained, I will ask my brother, Clarence Fishleigh, if he will perhaps point along here
951 while I talk, in case your Honor wants to glance up occasionally.

The Court: Is there any objection to that procedure?

Mr. Byron: Not at all.

The Court: Very well.

A. (Continuing) At the righthand side of this chart, Plaintiff's Exhibit 199 for identification, you see that I have broken down claims 8 and 9 into their various elements. That is, claim 8, as it appears in the patent, word for word, is at the righthand side, in the vertical column. I have placed opposite, in horizontal rows, the corresponding elements of the claims.

You will notice the little figures in parentheses; for instance, in Element 1 of claim 9, you will notice (1), and then a little lower down you will notice (3), and a little lower down (2).

That is to indicate that although the elements were quite similar in the two claims, they did not come in exactly the same order, and that is also to indicate to your Honor that in claim 9, we ran down through, and then the (1) element was all right, and then the element (2); and
952 then (3) and then (4) were two other separate elements.

The gist of the thing, the substance of the claim, has not at all changed by simply shifting them around in their mechanical position on the chart.

953 Now, that has been done as few times as possible, but wherever it has been done according to the patent, we have marked it so your Honor will know.

Now, in order to make clear what we have here and to explain what these various elements mean, so that we will have no difficulty later when your Honor may ask me, "Well, is that element 1 found in the Defendants' Lincolnweld process, or in some prior art practice," I have put down at the left-hand side, for reference, simply for convenience and reference, first a series of quotations from the patent specification itself, picking out those parts which

I thought were pertinent to the elements from which the arrow is run out.

That is merely as a matter of reference and for convenience, so your Honor won't have to go back and say, "What does the patent say in connection with element 2?" And go back to the patent and dig through three or four or five pages and find it.

Some may disagree with the sections I have picked here, but I think if your Honor will check me you will find I tried to pick all the sections from the specifica-
954 tion which are pertinent to the elements in this particular claim.

In each case you will note we have said where it was. Notice the first one, it shows Plaintiff's Patent page 3, Column 1, lines 64 to 67, and 72 to Column 2, line 6, and so on, down the line.

Also to make it convenient or to try to make the situation clear to all of us what the elements in the claims themselves mean, I have put on the left-hand side, photostatically reproduced, some figures which may be helpful.

First of all, at the top, as noted before, the figure is simply a photostatic reproduction from the Welding Handbook of 1942, Fig. 1, page 245.

Your Honor's attention has already been called to that figure in the Welding Handbook, and I think that you remember some of the Union Carbide and Carbon people had to do with writing that section.

Then below it, from the Unionmelt Apparatus Catalogue, 1945 Edition, pages 2 and 3; that is another figure which is more or less sectioned a little differently from that above; but I thought the two together might help.

I may say in that connection that the figure that Dr.
955 Doan explained to your Honor might well have been put on this chart to also show the internal mechanism, as far as any of us are able to make out.

I may say that, as I said before, I have worked in a great many of those tests and investigations with Dr. Doan, and I can subscribe to what he said about the process. As far as we know, with the limitation which he gave, we are not 101 per cent sure about some of the internal mechanism even now.

Underneath the flap, I have simply picked out some illustrations again from the Unionmelt Apparatus Catalogue, showing in the bottom two pictures page 15 and page 23, which show a weld of two different types of

welding, with a machine, and up above some diagrammatic pictures of sketches taken from page 41, page 36 and page 46 respectively, showing the type of welding and the general result as far as the penetration and width of the weld is concerned, taken again from the Unionmelt Manual.

I take those as illustrating the Jones et al. process, because all of my investigations checked with those of Dr. Doan and Dr. Willard, that the Unionmelt process,

956 when conducted either with the Unionmelt 20 flux or with the Unionmelt 90 flux, is an accurate exemplification of the teachings of the Jones et al. patent with which we are concerned.

Now, perhaps just one other word in connection with my reason for putting on this specification here at the side, at the left, so that when we come—your Honor appreciates, of course, that a claim in a patent is an attempt in just a few words, as few words as possible, to sum up and define what the invention is; to give in as few words—you might say telegraphing is pretty expensive. If you wanted to send somebody a summary by telegraph, well, put it there.

958 Q. Will you proceed, Mr. Fishleigh, to explain the material that you have here.

A. Looking first at, say, claim 9, I think we might take that as being typical of these two claims, although your Honor will see at a glance that there is a little difference in elements 2 and 3 of this claim from those of 8; but I think if we go through 9, 8 will be rather clear.

"The method of uniting metal work pieces by fusion depositing added metal from an electrode and coalescing such added metal with adjacent fused metal of the work, which comprises. * * *"

I have put over at the left, from the specification, so that we would know the substance of this method, a quotation from the specification as follows, and I think I had better read these references this first time, and then omit them.

960 The Court: Is there any objection to the receipt in evidence of the exhibit.

Mr. Byron: No objection.

Mr. Oberlin: It is purely illustrative, as I understand it, of what the witness is testifying; not otherwise.

Mr. Wolfe: That is right.

The Court: It may be admitted.

(Whereupon said chart marked PLAINTIFF'S EXHIBIT 199 was admitted in evidence.)

The Court: You may proceed.

The Witness: That first introduction, then, is described in the specification in the general language shown there on the chart which I think we have already been over. Element No. 1:

961 "* * * juxtaposing the work pieces to be united so that a space is provided there between at the line of intended union. * * *"

As your Honor has already seen, the space may be of one kind or another as shown on the chart under the flap. So there is no discussion needed there, although I point out in the specification where it describes it. The next one is rather important, however:

"* * * bridging the fusing end of said electrode and the adjacent fused local area of the work with a pool of material fused in situ without substantial gas evolution, said fused material being electrically conductive and active to cleanse the fused metal of the electrode and the work. * * *"

We get there to the heart, you might say, of the process, the gist of the process; that is, the way of expressing in this claim the feature which you have here described of the end of the electrode being submerged

962 in a pool of molten flux which acts as a blanket around the welding zone, and the current being transmitted through that pool of molten flux from the electrode to the plates.

963 With respect to that one I certainly want to read a couple of references in the specification, because it comes up time and time again, and it is one of the great differentiating features of this process and this invention from anything that I know of in the prior art.

Starting then in the second paragraph in the Note at the left:

964 The quotation from the specification, page 3, Column 1, lines 45 to 51, reads as follows:

"When a weld is to be made between beveled edges the operation is started by filling the groove, space, or gap between the edges of the objects with the welding composition, preferably in powered or granular form, and a substantial additional quantity of the composition is heated up along the groove, thereby overfilling the said groove."

Going on:

"The welding composition serves as an active instrumentality, or welding medium, inasmuch as it provides

heating means, controls the rate, penetration, and quality of welding, purifies the molten metal, and protects the molten metal."

Going on to the next quotation:

965 "* * * but it is important that the composition be substantially free from iron oxides uncombined with other ingredients of the composition (but being prefused with such ingredients, for instance), and from materials (such as carbonates or moisture) which evolve detrimental amounts of gas or vapor at welding temperatures."

"According to the welding method of the invention, the end of the welding electrode, which is preferably a bare metal electrode, is first inserted into the welding composition. Since the composition is non-conductive when cold, a conductive path for the welding current is provided by bridging the gap between the electrode and the work with, for example, a sliver of graphite or a wad of steel wool. The power is then applied, the welding composition is locally heated until it fuses and becomes conductive, forming a subsurface pool, and immediately thereafter the end of the electrode begins to fuse and the molten metal begins to deposit in the groove, displacing the

966 subsurface pool of fused welding composition. At the same time the edges of the objects being welded begin to fuse and to coalesce with the deposited metal. The electrode is then fed toward the work and moved along the seam at an appropriate rate, preferably by a mechanical device which may be similar to those which are extensively used in open arc-welding, and the welding proceeds without interruption."

969 Mr. Wolfe: May it please the Court, with the permission of the Court, we would like at this time to interrupt Mr. Fishleigh's testimony, in order to take the testimony of two short witnesses from out of town.

I understand that counsel for the Defendants are

970 agreeable.

Mr. Byron: Entirely so.

The Court: Very well.

(The witness was temporarily withdrawn.)

Mr. Fowler: Plaintiff calls Mr. Jackson.

T. M. JACKSON, called as a witness on behalf of the Plaintiff, having been first duly sworn, was examined and testified as follows:

Direct Examination by Mr. Fowler.

Q. What is your name and address, Mr. Jackson?
A. T. M. Jackson; Swarthmore, Pennsylvania.

Q. By what company are you employed?
A. Sun Shipbuilding and Dry Dock Company.

Q. How long have you been with that company?
A. Since 1918.

Q. What is your present position?
A. Electrical and welding engineer.

Q. Are you a member of any professional societies?
A. Yes, sir, I am a member of the American Welding Society, and the Society of Naval Architects and Marine Engineers.

971 Q. How long have you been a member of the American Welding Society?
A. Since 1918.

Q. When was that Society organized?
A. In that year.

Q. Now Mr. Jackson, I show you Plaintiff's Exhibit No. 163 for identification, which is booklet entitled Submerged Melt Welding, being a reprint from the Welding Handbook, 1942 Edition; and I will ask you if you had anything to do with the preparation of that document.
A. Yes, sir; I was Chairman of the Committee which prepared this particular report.

Q. And is that a standard reference work which describes the welding process usually called the Unionmelt process?
A. Yes, sir.

Mr. Fowler: I offer Plaintiff's Exhibit No. 163 for identification, in evidence.

The Court: Is there any objection?

Mr. Byron: No objection.

The Court: Admitted.

972 (Whereupon said document, PLAINTIFF'S EXHIBIT No. 163 was admitted in evidence.)

By Mr. Fowler:

Q. Now, Mr. Jackson, can you tell us anything with respect to a revision of this book?

A. Yes, sir, that was the first edition of the American Welding Society Handbook, and the second edition is being prepared at the present time, and will be issued, probably, in 1948.

Q. And did you have any connection with the revision of this Chapter?

A. As Chairman of that Committee, preparing that particular Chapter.

Q. Where is the Sun Shipbuilding and Dry Dock Company located?

A. Chester, Pennsylvania.

Q. How big was the ship yards prior to the second World War?

A. It comprised eight building slipways.

Q. Was it expanded?

A. During the war years it expanded to a total of twenty-eight ways.

Q. I show you a photograph on pages 10 and 11 of
973 this book, and ask you if that photograph accurately portrays the ship yard after the expansion.

The Witness: It does.

Mr. Fowler: I offer the photograph in evidence.

Mr. Becker: That will be Plaintiff's Exhibit 200.

(Whereupon said document was marked PLAINTIFF'S EXHIBIT 200 and admitted in evidence.)

By Mr. Fowler:

Q. Can you tell us how long that ship yard is?

A. A little less than two miles.

974 Q. Does your company use any legend or slogan with respect to the all-welded ship?

A. Yes; we have a slogan of "Creators of the All-welded ship."

Q. And how long have you used that slogan?

A. I think since about 1938 or '39.

Q. When did your company first build an ocean going ship; all-welded ship?

A. 1937.

Q. Can you tell us some of the facts or advantages which led your company to build all-welded ships?

A. We felt that there would be considerable saving in

weight of steel. That actually amounts to about 12 per cent, which would mean an equivalent in pay load that the ship could carry.

Also it enabled us to build faster ships, and, we felt, cheaper ships.

Q. What effect did the adoption of welding have with respect to shop operations?

A. Shop operations, as compared to a riveted vessel, we eliminated punching, reaming, bolting, riveting, the riveting operation itself, and caulking; all replaced by the single operation of welding.

I am talking about butt joints now only.

975 Q. And what effect did the substitution of welding have on man hours required by the construction?

A. It decreased the man hours.

976 Q. When did you personally first become acquainted with the Unionmelt welding process?

A. In 1936.

Q. And how did that come about?

A. I went to see a Unionmelt set-up over on Long Island, an experimental set-up.

Q. Did you see any demonstration of the Unionmelt process?

A. I saw a demonstration about a year later, or less than a year later in the Coatesville plant of the Lukens Steel Company.

Q. Did your company take any action about that time with respect to the Unionmelt process?

A. We signed a license agreement with the Linde Air Company to use it in 1936.

Q. Tell us something about the methods used in ship construction?

A. You mean, in welded ship construction?

Q. Yes.

A. The biggest advantage we saw in this welding was that we were enabled to build very large sub-assemblies in our shop, and on those as compared with riveting, we did a very much quicker job with about one-sixth of the man-hours on the shop assemblies.

977 Also, the welding of them with the Unionmelt process was a major factor in keeping those subassemblies straight and more nearly to accurate dimensions, because in the Unionmelt process there was considerably less distortion on relatively thin plates and less shrinkage than

with manual welding. That was a very important consideration.

These big subassemblies are a tank length long, about 40 feet long, and about 30 to 35 feet high, weighing up to 25 tons. They are transported out to the shipways and assembled on the shipways and the straighter they are and the less distortion and more accurate we can hold the dimensions, means additional great savings in the time required to assemble and fit these big, large subassemblies together prior to welding on the ways.

Q. You have mentioned distortion. I wish you would explain a little more specifically what distortion means.

A. I meant by distortion that when you held a butt joint or any kind of a joint in a light plate, you get the plate wavy, it bends, and where it gets fitted into the ship it must be straightened out straight again.

978 Q. Now, specifically, with regard to manual welding with a coated rod:

Tell us about distortion in that connection?

A. In manual welding with a coated rod, where you have to put a series of beads on, one on top of the other, each bead that you put on tends to add to the distortion, and also to add to the shrinkage.

In the Unionmelt process, you get one pass on each side of the plate, a total of two passes, and it results in less distortion and less shrinkage.

Q. Before the war production years, what was the elapsed time that a ship was on the ways?

A. Ten to twelve months.

Q. And was that time reduced?

A. Yes, sir, during the war, with our latest method of welding in the shop, and erection, we reduced that to approximately three months.

Q. And to what do you attribute that reduction in elapsed time?

A. Very largely, to the welding, and very largely, to the speed with which we could make our largest ship subassemblies.

979 Q. Now, I wish you would look at the photograph that I believe is on page 36 of this same book.

A. Yes, sir.

Q. I ask you if that fairly illustrates a subassembly going into a tanker?

A. Yes, sir, that illustrates a transverse bulkhead.

Q. And was that photograph taken in your shipyard?

A. Yes.

Mr. Fowler: I offer the photograph in evidence as Plaintiff's Exhibit No. 201.

(Whereupon the said photograph was marked PLAINTIFF'S EXHIBIT 201 and admitted in evidence.)

By Mr. Fowler:

Q. While we have the book here, I direct your attention to the opposite page, page 37. There is a photograph at the top of that page. I ask you what that purports to portray.

980 A. That represents the first vessel that we built of the T-2 class.

Mr. Fowler: I offer that photograph in evidence as Plaintiff's Exhibit 202.

(Whereupon the said photograph was marked PLAINTIFF'S EXHIBIT 202 and admitted in evidence.)

By Mr. Fowler:

Q. I am not sure that you have mentioned what percentage of the welding on subassemblies was done by the Unionmelt process. Will you tell us that?

A. On subassemblies, 75 to 80 per cent was done with the Unionmelt process.

Q. Did you ever use any other automatic welding process in shipbuilding?

A. No, sir.

981 Q. Did you ever hear of any other automatic welding process being used in ship construction?

A. I did not.

Q. Now, after the subassembly was taken over to the way, would you tell us how the welding, in the ship construction on the way, was done?

A. It was all done by manual welding.

982 Q. And would you tell us any facts with respect to automatic welding on the ways?

A. We did no automatic welding on the ways. The largest percentage of it is in a position that is not susceptible to being done automatically, because it is a vertical and overhead position; so we didn't do any automatic welding on the ship ways at all. It was all manual.

Q. You have mentioned the T-2 tanker. Will you tell us how many of those tankers Sun Ship built?

A. 198.

Q. During what period of time were they built?

A. They were built all during 1940 to 1945 inclusive,—'39 to '45; I think that is right. I am not 100 per cent sure of that first date.

Q. Can you tell us how big those tankers were?

A. They were approximately 540 feet long, a 70-foot beam—that means the width—and about 40 feet depth, and rated a 18,500 dead weight pounds.

Q. Did other ship yards build the same tanker?

A. Three others.

Q. Will you give us their names?

A. Alabama Shipbuilding and Dry Dock Company; and Kaiser Yard at Swan Island, and Marin Ship Yard, both in California.

Q. Do you know how many T-2 tankers those other three yards built?

A. I think some place between 225 and 240. I don't have an accurate record.

Q. And did your own company have any connection with the construction of those tankers in the other ship yards?

A. Only to the extent that we designed the ship and we furnished the plans and specifications for them, to the other yards.

Q. Now, what was the total number of ships built in your ship yard in this period you have mentioned, 1939 to 1945?

A. 289, I think it was.

Q. And that included the 198 T-2 tankers, didn't it?

A. Yes. 293 total; that included the 198 T-2 tankers, yes.

Q. What other ships were included?

A. The others were miscellaneous cargo ships.

Q. Now, I believe you mentioned a saving in man hours through the use of the Unionmelt process. I ask if you can tell us any more facts with regard to the saving of labor in ship construction by this process.

A. The saving in man hours, which is labor, of course, was about 30 per cent, 30 to 35 per cent less man hours on an all-welded ship than on a comparable riveted ship, a riveted ship of comparable size.

Q. What kind of men were required for riveting or for hand-welding?

A. The riveting job requires very skilled men and the

hand-welding job requires very skilled men. I mean, on the main seams of an all-welded vessel.

Q. What was the total number of manual welders you had at the peak of war production?

A. At the peak we had a total of about 7500 manual operators.

Q. How many of those were able to be used on main seams?

A. Only about 1,000.

Q. What kind of men could be used for the Unionmelt process?

A. They could be much less skillful and more easily trained and older men, because it is a much easier job. It is not an arduous job. It requires a great deal less skill.

985 Q. What was the relationship of labor required as between manual welding and Unionmelt welding on a given amount of welding?

A. You mean—will you repeat that question again?

Q. The output in feet of weld per man by manual welding as compared with Unionmelt.

A. The Unionmelt men could do approximately six times as much work on a given thickness, comparable thickness of plate.

Q. What were the plate thicknesses used on ship construction?

A. On the main structure, from 3ths up to and including 1¼ inches.

Q. What would the average plate thickness be?

A. Approximately ¾ of an inch.

Q. Was there any saving in welding rod?

A. Welding rod was about half for Unionmelt welding of that required for manual welding for a given thickness, of course.

Q. Can you tell us anything else—

A. I would like to restrict that statement to butt welds only, on welding rod. It is not true of fillet welds.

Q. Have you anything else to say with regard to the 986 use of the Unionmelt process in your ship yard?

A. Nothing except that we also used the process in building pressure vessels.

Q. Generally speaking what is your experience?

A. Very satisfactory. We build vessels to the A.S.M.E. and A.P.I.-A.S.M.E. Codes, the controlling agencies that control those kind of vessels, to be sure they are safe.

Q. Did you meet all code requirements with that process?

A. Yes.

Q. Did you ever see a Lincoln Electric Company Electronic Tornado Arc?

A. I have.

Q. Can you tell us anything about that?

987 The Witness: I can only say that we tried out the Electronic Tornado and after considerable length of trial we did not use it.

Mr. Fowler: You may cross-examine.

Cross-Examination by Mr. Stewart.

Q. Mr. Jackson, you said that the man hours necessary, approximately, for the building of a ship as between a riveted ship and an all-welded ship was that the welded ship was 35 per cent less in man hours used, is that right?

A. That is right, yes, sir.

Q. In welding a ship over 50 per cent of the welding is hand-welding, is it not?

A. If you take the total ship, yes.

988 Q. So that the 35 per cent reduction is more due to the use of hand-welding than automatic welding? At least the automatic welding does not account for the entire 35 per cent, is my only point.

A. No. It does not account for the entire 35 per cent, no.

Q. You recall, do you not, that the German pocket battleships were all-welded ships in the 20's, were they not?

A. Approximately that time.

989 Q. Whenever they were made.

A. Whenever they were made, although I do not recall now when that was.

Q. That was before 1930, was it not?

A. I would not put any date on that, because I do not remember.

Q. All right. You signed a license agreement in 1936 with the Linde Air Products Company, did you not?

A. Our company did.

Q. I mean, your company.

A. Yes, sir.

Q. And was there at the same time a rod purchase agreement executed by your company?

A. I do not know that. That was handled by our Purchasing Department, and I do not know. I do not think that there was, however.

Q. You say, you do not know, but you do not think that there was?

A. I do not think so; I do not think that there was any rod agreement, any agreement to buy rods from any particular source.

Q. What about in recent years?

A. No, sir, not to my knowledge.

Q. You do not know about that?

A. No, sir.

990 Q. Now, you are an electrical engineer?

A. Yes, sir.

Q. Mr. Jackson, in the Unionmelt process, as practiced in your shipyards, is it not a fact that the necessary heat for melting steel is provided by an electric arc?

A. I could not answer that question; I do not know.

Mr. Stewart: That is all.

LEIGH R. SANFORD, called as a witness on behalf of the plaintiff, having been duly sworn, testified as follows:

Direct Examination by Mr. Fowler.

Q. What is your name and address?

A. Leigh R. Sanford; Pelham Manor, New York.

Q. Please tell us about your connection with the Maritime Commission.

A. At the time the Maritime Commission was created, by the Act of 1936, I had formerly been an employee of the United States Shipping Board Emergency Fleet
991 Corporation, and I transferred to the Maritime Commission.

In the early part of that employment I was chief of the Design Section in the Technical Division of the Commission.

Later on I became chief of the Inspection Section, charged with the inspection of ships under construction.

Shortly after the war, the construction activities of the Maritime Commission were decentralized, and divided up into four regions, the East Coast region, the Gulf Coast region, the West Coast region, and the Great Lakes region.

A regional director was appointed for each one of those four regions, and at that time I was appointed regional director for the Gulf Coast region, with offices in New Orleans, Louisiana.

In about the spring of 1944, the Great Lakes region, with offices in Chicago, was also placed under my jurisdiction. In July, 1945, the East Coast region, with offices in Philadelphia, Pennsylvania, was also placed under my jurisdiction. In September of 1945 the West Coast region, with offices in Oakland, California, was also placed un-
992 der my jurisdiction.

At that time my title was changed to Director of Construction.

Q. And you had charge of all of the regional offices, is that correct?

A. That is correct.

Q. And what is your present connection?

A. I am executive vice president of the Shipbuilders Council of America.

Q. What was the function of the Maritime Commission after it was created?

A. The function of the Maritime Commission after it was created, primarily, under the national policy enunciated in the Merchant Marine Act of 1936, was to promote the American merchant marine in various ways, particularly by modernizing it and bringing it up to date.

Pursuant to that policy, the Maritime Commission in 1936 and 1937 originated a ten-year construction program of 50 ships a year for a period of ten years, for the purpose of replacing obsolescent ships and bringing the merchant marine up to date.

Q. What happened to that program?

A. Shortly thereafter the war started in Europe and
993 that program was doubled and afterwards it was again doubled, and even before we got into the war, emergency shipbuilding was started and several yards established for the building of Liberty ships; and of course after we got into the war that program was increased many times.

Q. What was the limit on the construction of ships?

A. It ultimately developed that the limit on the construction of ships was not shipyard capacity but the capacity of the steel mills to produce the necessary steel; we had more capacity than we could obtain steel for.

Q. What was the total number of ships built for the Maritime Commission?

A. I do not have the exact number as a matter of record, with me; but based on my best recollection I would say that number is between five and six thousand ships altogether.

Q. Taking the situation in 1937, when the program was first initiated, what can you tell us about the riveting or welding of ships?

A. Well, up until that time the usual ship construction method had been riveting. Welding was beginning to come into use to a certain extent, and came into use rather
994 rapidly from that time on.

As a matter of fact, the first large shipyard which was planned and designed exclusively for the construction of all-welded ocean-going vessels was started in 1939 at Pascagoula, Mississippi, by the Ingalls Shipbuilding Corporation.

Q. How did methods develop in shipbuilding construction?

A. Very rapidly.

Q. And at the peak of war production, what would you say about the methods used in ship construction?

A. Well, welding was used to a very great extent. It was used in all emergency yards building Liberty ships, but not to the same extent in each one.

The extent to which it was used was left, by the Maritime Commission, largely to the judgment of the operator of the shipyard, and that judgment was accepted. It varied from yard to yard.

Q. How many yards used the Unionmelt process?

A. As far as I am aware, all yards building ships for the Maritime Commission used the Unionmelt process.

Q. Taking welding generally, what were its advantages as against riveting of ships?

995 A. It permitted, as Mr. Jackson testified, the more rapid assembly of subassemblies, permitting larger subassemblies; reduced both weight and, as a result of that, cost of building ships, and expedited the building of ships to a very great extent.

Q. Can you tell us anything about the training of riveters?

A. Yes. The training of riveters is a rather difficult job. It requires long training to produce a competent riveter

on ship construction, quite different from a riveter on ordinary structural work.

The Newport Shipbuilding & Drydock Company at Newport, Virginia, had an apprentice system for training riveters—they had all negro riveters—for a great many years, and they were reputed to be the best riveters in the country.

Q. How does that compare with training welders?

A. The training program adopted during the war for training welders for hand-welding took from four weeks to several months, depending upon the adaptability of the particular individual.

Q. Can you tell us anything about the efficiency of a welded joint as compared with a riveted joint?

A. A welded joint is much more efficient than a
996 riveted joint. As a matter of fact, it is just as efficient as the original material, whereas a riveted joint is not.

Q. What were the advantages specifically of the Unionmelt welding process as compared with manual welding?

A. There were quite a number of such advantages. I jotted a few of them down, if you don't mind my referring to these notes.

One of the advantages was a much deeper penetration as a result of the Unionmelt method, as compared with manual welding. It reduced the amount of manual welding and, as a result of that, helped us out in our difficulty of obtaining skilled manual welders. There was a very critical trade during the war, and it was impossible to train enough competent welders, manual welders; so the extent to which you could use Unionmelt helped out on that shortage.

It reduced the time required for sub-assemblies; gives a smooth appearance of the weld, compared with a rather rough appearance; on long, straight welds, it made possible greatly increased speed, particularly with the thicker plates.

The use of the Unionmelt machine was more nearly
997 foolproof than that of ordinary hand-welding. Not nearly the skill was required in the operation of the Unionmelt machine, and less time was required to train operators.

There was considerably less distortion, as the result of the Unionmelt process, as compared with manual welding; and in connection with manual welding, there was always a tendency to oversize welds on the part of the operator,

which of course resulted in wastage of electrodes as well as man-hours.

Those are the principal advantages of Unionmelt, as compared with the manual.

999 Q. Can you tell us anything about the use of other automatic welding processes in ship construction?

A. No use of other automatic welding processes in ship construction, during the period of the war, came to my attention.

Q. Did you ever hear of a Robinoff process?

A. I cannot say that I have.

Q. Did you ever hear of a clay-lime-ferromanganese process for welding?

A. I do not have any recollection of having heard anything about it.

Q. You have heard the word "bottleneck", have you not?

A. Frequently.

Q. Was there any labor bottleneck in the building of ships?

A. Yes, sir, there were a number of labor bottlenecks, and the most critical bottleneck was incompetent manual welders.

Q. You were present here yesterday and heard Mr. Miller testify with respect to anchor chain, were you?

A. Yes.

1000 Q. Can you tell us whether or not another chain was in plentiful supply, or otherwise, during the period of war production?

A. No, sir, there was a considerable period during the war when another chain was an extremely critical material, so much so that some ships were delayed in going to sea for lack of anchor chain; and in some cases of which I have personal knowledge, we sent some ships to sea with only one anchor chain, where they normally would carry two.

In other cases we sent ships out for trial with one chain, and then when they came back, we immediately removed the one chain and put it on another ship, and sent it out for trial.

Mr. Fowler: You may cross examine.

Cross-Examination by Mr. Stewart.

Q. Mr. Sanford, this Unionmelt process to which you have referred: what do you understand by that? What does that mean to you?

A. Well, it is an automatic process for depositing metal to form a weld by the use of a machine designed for that purpose.

Q. Is it commonly known to you as a submerged
1001 arc process?

A. I would not say so, no, sir; it is commonly known to me as the Unionmelt process.

Q. Do you know what provides the heat for the melting of the plate when this process is used?

A. Well, the source of the heat is electric current, of course.

Q. And the current creates an electric arc, does it not?

A. I really cannot answer that question, because I do not know the details of the process.

Mr. Stewart: That is all.

Mr. Fowler: That is all, Mr. Sanford.

The Witness: Thank you.

1002 WALTER TURNER FISHLEIGH, called as a witness on behalf of the Plaintiff, having been previously duly sworn resumed the stand and testified further as follows:

Mr. Wolfe: I offer in evidence as Plaintiff's Exhibit 203 a copy of the 1945 Catalogue of the Lincoln Electric Company.

The Court: Is there any objection?

Mr. Byron: No objection.

The Court: It may be admitted.

Mr. Wolfe: For convenience I will ask that it be marked in parentheses Plaintiff's Deposition Exhibit 4.

(Whereupon said document was marked PLAINTIFF'S EXHIBIT No. 203 and admitted in evidence.)

Direct Examination (Continued) by Mr. Wolfe.

Q. At the top of page 4 of this catalogue, Plaintiff's Exhibit 203, Mr. Fishleigh, is a section with the heading, "Improves Working Conditions", and beneath that is this paragraph:

"Absence of smoke, fumes, radiated heat, spatter and visible arc eliminates the discomforts of conventional
1003 open arc welding and results in an increased operating factor for lower welding costs."

Will you tell us, Mr. Fishleigh, whether or not the Lincolnweld operation which you told us yesterday you had seen at the Tecumseh plant and at the Wicks Boiler Plant, and on your second visit to the Graver plant, was in conformity with or different from that description in the catalogue?

A. They were, yes, sir.

Q. They were which?

A. They were in conformity with this description in the catalogue.

Q. I want to direct your attention next to the demonstration which was made at the Graver plant pursuant to Court Order, which I believe was last May.

Did you at that time have any opportunity to observe the relative location of the welding rod or electrode and any pool of fused flux?

A. Yes, sir, I did, throughout a considerable part of the demonstration, in all.

Q. What did you observe in that respect?

A. During such parts of the demonstration as
1004 the glare was not too bright and the spatter not too much, I could clearly see that the end of the electrode was submerged in a molten pool of flux.

Q. Have you prepared a set of charts similar to Exhibit 199 indicating by arrow lines on the same the quotations from the specification of the patent which describe the exemplary operation and flux constituents corresponding to the elements of the remaining claims in issue?

A. Yes, sir.

Q. That is, beyond the two charts there?

A. Yes, sir, I have.

Q. How would you define equivalent steps or elements of processes or compositions?

A. Well, equivalent steps or elements are similar steps

or elements operating in substantially the same way to produce substantially the same results.

Q. Have you on these charts which you have mentioned as having prepared also indicated whether or not in your opinion the equivalents so defined of the steps or elements of these claims, are found in the accused Lincolnweld process and flux composition?

1006 The Witness: Yes, sir, I have.

By Mr. Wolfe:

Q. In what manner?

A. Well, in an attempt to make it clear, I have extended the chart out to the right, and photostatically reproduced thereon some figures from the Unionmelt catalogue, which may be conveniently compared with—or rather, I mean to say, of course, from the Lincolnweld Catalogue.

Q. That is Plaintiff's Exhibit No. 203?

A. Yes, sir, from Plaintiff's Exhibit No. 203, so that it may be convenient to compare those figures at the right, of the Lincolnweld process, from the catalogue, with those on the left, of the Unionmelt.

Then just at the right of the claims, I have put on, in each case, or, I have put down, a narrow column with a heading "Elements Found in Lincolnweld Process" for the process claims, or "In Lincolnweld Composition" for the composition claims. Then—

1014 Q. Had you completed your answer?

A. No. I was just right in the middle of it. If I may, I would like to explain so the chart will be intelligible.

Q. Very well. Go ahead.

A. I had just stated that just to the right of each group of claims I had put a narrow vertical column, and in that column, if I found the response for the element in the horizontal row, I would put a "Yes", and if not, I put a "No".

Then in order to make clear the basis for that "Yes" in my opinion, I have run out from it and put a little explanatory note which I think will make clear the situation upon which the "Yes" is based.

Now, in order to make those notes clear, I have added upon the photostatic copy reproduction from the Lincolnweld catalogue Figures numbers, such as 1, 2, 3 and so forth, so that in the note, the explanatory note, I can refer to the different elements which are shown in that Lincolnweld picture.

With that in mind your Honor can see in any set of
1015 elements whether or not, in my opinion, the equivalent is found in defendant's structure, with an explanatory note justifying the "Yes" if it is a "Yes" in that column.

Mr. Wolfe: I renew the offer of this set of charts as Plaintiff's Exhibit 204.

1017 Mr. Wolfe: For convenience, for future reference, I will ask that the book of charts as a whole be marked as Plaintiff's Exhibit No. 204 in evidence,
1018 and that the individual sheets thereof be marked consecutively as 204-A, 204-B, 204-C, and so forth.

(Whereupon said document was marked PLAINTIFF'S EXHIBIT No. 204-A to J, and admitted in evidence.)

Mr. Wolfe: Cross-examine.

Mr. Byron: With the permission of the Court, we will reserve the right to cross-examine until we have had an opportunity to study these charts, because obviously, we cannot do that in a matter of a few seconds here.

The Court: Is there any objection?

Mr. Wolfe: I have no objection to that, no, your Honor.

The Court: All right.

1019 Mr. Wolfe: I would like to read in evidence at this time a portion of the deposition of one of the officers of Lincoln Electric Company, one of the Defendants here. I do not know whether we have advised the Court, or not, but in the taking of depositions, preparatory to trial, both sides have agreed to a waiver of filing, so that we have the respective original depositions in our possession.

1020 Mr. Wolfe: The first one which I desire to read in evidence is a portion of the deposition of George Gideon Landis, beginning at page 400, which is the beginning of his deposition.

1024 Mr. Wolfe: I believe I previously identified this deposition as that of George Gideon Landis, beginning at page 400 of the deposition taken at Cleveland.

"Q. What is your full name, Mr. Landis?

"A. George Gideon Landis.

"Q. What is your home address here?

"A. 1884 Belvoir Boulevard, South Euclid, Ohio.

"Q. And your present employment?

"A. Lincoln Electric Company.

"Q. What position or office do you hold there?

"A. Vice president in charge of engineering.

1025 "Q. How long have you held that position?

"A. About six months.

"Q. How long have you been with the Lincoln Electric Company?

"A. About 23 years.

"Q. What was your position prior to being vice president?

"A. Chief engineer.

"Q. How long were you chief engineer?

"A. Since 1931.

"Q. What were your duties as chief engineer?

"A. They changed during the course of that period. Up until 1934 I had charge of motors and welders and accessory equipment, and in 1934 I was also given charge of the automatic development department. They haven't changed officially since then with the exception of some duties that have to do with tooling, which would not be of interest to you.

"Q. What did you have to do as in charge of the automatic welding development department?

"A. Up until the time that it was put under my supervision, it was headed by Mr. Stine, and in taking over
1026 the department he reported to me directly instead of to Mr. Lincoln directly, so I had supervisory charge of all the work in the department.

"Q. Was it up to you to outline the programs of development that were to be followed and to supervise the progress made, and that sort of thing?

"A. Yes. To be more specific, Mr. Lincoln made out the general policies and I translated those into terms of general development lines, and the actual work was carried out under the supervision of Mr. Stine, and later on Mr. Maurice Taylor.

"Q. Did you have charge of engineering design for production?

"A. Yes; all engineering that had to do with those particular products.

"Q. Were you responsible for any production problems as such?

"A. Not for the actual producing of any equipment in production, but I was responsible for any changes in design or any changes in anything which would affect the final product.

1027 "Q. Did that responsibility include supplies such as flux and things of that kind, in addition to equipment?

"A. Yes.

"Q. What was your engineering education?

"A. B.S. and E.E., Ohio State, '21.

"Q. Have you published any scientific or engineering articles?

"A. There have been some published over my name that I have read. I have not been very active in publishing articles. I haven't given any talks of any kind of an educational nature; that is, in schools. There have been some, though; very few. I am not very active along that line.

"Q. What company or companies were you with before you went with Lincoln Electric Company?

"A. I went with General Electric Company at Fort Wayne, Indiana, in '21, and with Westinghouse Electric and Manufacturing, East Pittsburgh, in '22, and came with Lincoln in '23.

"Q. Did you have anything to do with welding at
1028 either of those companies?

"A. No.

"Q. Had you had any welding experience before you came to The Lincoln Electric Company?

"A. No.

"Q. What experience have you had in the field of chemistry, especially with respect to silicates?

"A. I have had no experience except as it may have been in connection with development work in our own laboratory.

"Q. What preparation have you made for this examination this morning?

"A. I have made no preparation as such except to glance over the testimony, and I also, of course, witnessed some of the depositions at the other deposition hearing.

"Q. That is, you were present?

"A. I was present here at some of it, and I have glanced over the ones that I didn't witness.

"Q. Now, you appreciate from that that in the Lincoln Company's activities we are especially concerned
1029 with what you people call the Lincolnweld process.

"A. Yes.

"Q. And that Lincolnweld process is a process of electric welding, is it not?

"A. That is right.

"Q. And in that Lincolnweld process a metal electrode

is melted, and the melted metal is deposited on some metal work piece; is that right?

"A. That is right.

"Q. The metal melted from the electrode is coalesced with the metal of the work piece, is it not?

"A. I would say so, as in all arc welding.

"Q. In other words, the metal of the work piece along the joint is fused and coalesced with the melted metal from the electrode; is that right?

"A. Yes.

"Q. In the course of operating the Lincolnweld process, is there a pool of fused flux more or less below the electrode?

"A. There is a pool of molten flux. I know that it is behind the electrode. I am not sure what you mean
1030 by 'below.' I would question that very seriously.

"Q. Is that pool of flux fused by the passage of electric current from the electrode to the work piece?

"A. In the process that I am familiar with, I would say no. If you mean could it be fused, there is no question that the flux can be fused by the passage of current in such a manner.

"Q. I am speaking now of the Lincolnweld process as it is commonly practiced, and as you people describe it in your literature, and so on.

"A. No, the flux is fused by the arc itself.

"Q. The pool of flux is fused in situ or in place rather than being fused in a pot and then put in there?

"A. Probably both places.

"Q. In that pool of fused flux in the Lincolnweld process is overlaid by a layer of unfused granular flux, is it not?

"A. If there is sufficient flux applied originally, yes.

1031 "Q. And in the normal operation of the process, that is so, is it not?

"A. Yes, I would say so.

"Q. The granular flux in practicing the Lincolnweld process is merely put up along the joint that is to be welded so that if there is a groove, that is overfilled; is that right?

"A. Yes; in case there is a groove.

"Q. The electrode projects down into the unfused granular flux, does it not?

"A. Yes

"Q. Is the top layer of unfused granular flux in contact with or touching the electrode?

"A. I would like to have that question read.

"Mr. Wolfe: Read it.

"(Question read.)

"A. Yes; it probably is. It is at times, anyway.

"Q. The unfused granular flux is substantially non-conductive?

"A. Yes.

1032 "Q. So that little or no current flows from the electrode through the unfused granular flux, is that right?

"A. That is correct.

"Q. Is the electrode in electric contact with the underlying pool of fused flux at any time during the operation of the Lincolnweld process?

"A. I do not know, but I do not believe it is.

"Q. Why don't you think it is?

"A. In the first place, you understand you can't see it very well, so that you must depend upon the things that you can reason out, and with the arc present we know that to be a fact, that with the arc present there is a force which blows the molten flux away from the point where you are welding. That is evidenced further by the markings on the head after the weld has been finished.

"Q. Is the fused flux used in the Lincolnweld process, and by that I mean the flux in state of fusion, electrically conductive?

1033 "A. That is a very general term, but I would say yes, if I understand your question properly.

"Q. And does its electrical conductivity increase with increase in temperature in the molten state?

"A. That is correct, generally speaking, yes.

"Q. That is what is sometimes known as a negative temperature resistance characteristic, is it?

"A. That is correct.

"Q. In carrying out the Lincolnweld process is any electric current passed from the electrode to the work piece through the pool of fused flux?

"A. I can't say definitely that it never happens. I would say it is not normal to the process.

"Q. But you think it may happen sometimes?

"A. I believe it is possible. I have no reason to believe

that it does, but if the molten flux were in contact with
1034 the wire at any time during the operation, some current would flow through it. It would be of very low value.

"Q. Well, to put it another way, knowing that this fused flux is electrically conductive, then if it does touch the electrode, then, certainly, current flows through it.

"A. That is correct.

"Q. And current passing through the fused flux would generate heat, would it not?

"A. Yes.

"Q. And that heat would aid in melting either the electrode or the plate in bringing about a coalescence of the two?

"A. Yes."

That is the end of the part I intended to read.

Mr. Byron: What is the page at which you concluded, Mr. Wolfe?

Mr. Wolfe: Page 407. Then there is one further short portion beginning at page 436, the last question on that page:

"Q. What, according to your recollection, was the first
1035 time that the Lincoln Electric Company used submerged melt welding in any commercial installation, either in their own plant or elsewhere? By 'commercial installation,' I mean for production purposes.

"A. I believe the first that I saw was at the Graver Tank Corp.

"Q. Do you remember when you first saw that?

"A. It was sometime in '42, as I remember."

1037 Mr. Wolfe: May it please the Court, I would like to inquire of our opponents at this time whether or not they plan to cross-examine Mr. Fishleigh this afternoon, or would prefer to reserve that until Monday morning.

1038 Mr. Byron: There will be no cross-examination of the Witness Fishleigh.

1039 JOHN P. MORRISSEY, called as a witness on behalf of the Plaintiff, having been first duly sworn, was examined and testified as follows:

Direct Examination by Mr. Fowler.

Q. Tell us your full name and address, please, Mr. Morrissey.

A. My name is John P. Morrissey; my address is 1710 West Wayne Street, Fort Wayne, Indiana.

Q. You came here today under subpoena, did you not?

A. Yes, sir.

Q. When did you first become acquainted with the Unionmelt welding process?

1040 A. About 1938.

Q. And in what connection did you become acquainted with it?

A. I had seen it done. However, I had no direct connection with it at that time. It was a question of my being in and out of plants—one particular plant.

Q. What was that plant?

A. The A. O. Smith Company, which at that time was working, not with Unionmelt, but which had been doing some research along that line; and I did not know of the process at that time.

Q. With what company are you at the present time connected?

A. The General Electric Company.

Q. What is your position?

A. Welding engineer in the laboratory.

Q. Where is that located?

A. Fort Wayne, Indiana.

Q. How long have you been with the Fort Wayne Laboratory of the General Electric Company?

A. Since January, 1940.

Q. Did that company have anything to do with turbo superchargers?

1041 A. Yes, sir. We made the biggest majority of the turbo superchargers that were used during the war.

1042 Q. What use was made of those superchargers?

A. Well, the supercharger is a mechanism that is used to compress air and feed the air to the carburetor of an airplane engine so that the machine will have essentially

the same air pressure at heights of, oh, 20,000 feet or thereabouts, that it would have the same pressure on the gas in the carburetor as it would have at sea level.

Q. What planes used those superchargers?

A. Pardon me?

Q. Could you tell us what planes used those superchargers?

A. Well, they were mostly used on P-38s, B-17s and B-29s.

Q. Was a plant built in that connection?

A. Yes, sir. We had a plant especially built at Fort Wayne for supercharger production.

Q. Can you tell us the size of that plant?

A. I think the ground comprises about 47 acres.

Q. And what did the plant cost, with equipment?

A. Approximately twenty-eight million dollars.

Q. When did production begin?

A. About the middle of 1942, in this plant.

Q. How long did it continue?

1043 A. We worked what was considered full production or scheduled production up until VE Day, and then we were on a smaller number, that is, the production was cut practically in half between VE Day and VJ Day.

Q. Now, will you tell us about the operating conditions of the supercharger?

A. Well, it was mounted in the nacelle, and the turbine wheel operated from the exhaust gas from the engine, and it worked at a temperature of 1650 degrees Fahrenheit and turned up 26,500 revolutions a minute.

Q. And did that require a good quality metal?

A. Oh, yes. The very nature of the temperatures and the speed that it was traveling, it had to be a first-class metal, perfect metal.

Q. I show you a photograph.

Mr. Fowler: First I will have it marked for identification.

(Whereupon said photograph was marked Plaintiff's Exhibit 205 for identification.)

By Mr. Fowler:

Q. Does that accurately portray the wheel as welded with Unionmelt?

1044 A. Yes, sir.

Mr. Fowler: I ask that this other photograph be marked for identification.

(Whereupon the said photograph was marked Plaintiff's Exhibit 206 for identification.)

Mr. Fowler: And I also ask that this piece of equipment be marked.

(Whereupon the said article was marked Plaintiff's Exhibit 207 for identification.)

By Mr. Fowler:

Q. I show you the photograph, Plaintiff's Exhibit 206 for identification, and ask you if that accurately portrays a portion of that wheel?

A. Yes, sir.

Q. I show you Plaintiff's Exhibit 207 for identification and ask if that is a piece of that wheel as welded with Unionmelt?

A. That is right. That is a cross-section of the wheel.

Mr. Fowler: I offer the three exhibits in evidence, if the Court please.

Mr. Stewart: No objection.

1045 The Court: They may be admitted.

(Whereupon the said photographs marked PLAINTIFF'S EXHIBITS 205 and 206, and the said articles marked PLAINTIFF'S EXHIBIT 207 were admitted in evidence.)

Mr. Fowler: I ask that this be marked for identification as Plaintiff's Exhibit No. 208.

(Whereupon the said photograph was marked Plaintiff's Exhibit 208 for identification.)

Mr. Fowler: I ask that this be marked Plaintiff's Exhibit 209 for identification.

(Whereupon the said photograph was marked Plaintiff's Exhibit 209 for identification.)

By Mr. Fowler:

Q. Do these two photographs, Plaintiff's Exhibits 208 and 209, accurately show the two parts of the wheel before they are put together and welded?

A. Yes, sir.

Mr. Fowler: I offer these two photographs in evidence, if the Court please.

1046 Mr. Stewart: No objection.

The Court: They are admitted.

(Whereupon the said photographs marked PLAINTIFF'S EXHIBITS 208 and 209 were admitted in evidence.)

By Mr. Fowler:

Q. I would like to have you tell us how that wheel was originally made, before welding was adopted?

A. Well, the wheel blanks were drilled; there were staggered holes drilled in the wheel blank, and then keyed buckets fitted down in there. This fit had to be within one-tenth of a mill, and they were staggered.

There was one long neck bucket and one short neck bucket, and they were fitted down in the holes in the wheel blank.

Q. What is a bucket?

A. Well, this is a bucket here (Indicating). It is a piece of vitalium made with the lost wax pattern method of casting, and it is a high temperature alloy. It has a curvature in here (indicating) so that the hot gas can hit it and drive the turbo wheel.

Q. Is it the same thing as a blade?

1047 A. Well, that is just a figure of nomenclature there. It could be called either a blade or a bucket.

Q. How much is a mill? You said, one-tenth of a mill.

A. One thousandth of an inch.

1048 Q. Can you tell us anything about the time that it took to manufacture a wheel by that method?

A. Well, it was built up on a production schedule, and to tell you accurately how long it required to make one wheel, I don't believe I could.

However, it would be in the neighborhood of four and a half hours for the entire operation, that is, drilling holes, and fitting the blades, or the buckets, in the wheel blanks.

Q. Now I would like to have you take the photographs and explain to the Court how the wheel was made by the use of the Unionmelt welding.

A. Well, your buckets here, as shown in this photograph, were laid in that fixture, there, and then one of these wheel blanks was inserted down in there. This was ground after the top of the fixture was placed on there; it was put in an internal grinding machine, and then the buckets—that is, the ends of them—were ground, so that these wheel blanks fitted down in there, and it was a fairly tight fit. That is, it was a slide fit, but it was not a sloppy fit; it was a good tight fit.

Then they were pre-heated; they were pre-heated to
1049 600 degrees Fahrenheit; and then automatically welded with the Unionmelt.

Q. Can you show the Court on one of those photographs where the Unionmelt weld is?

A. Yes, sir, this is it, right in here (Indicating to Court); and in this case, right here. (Indicating.)

Q. And how long did it take to make a wheel with the Unionmelt welding?

A. Why, it was welded on two sides, and one operator would do the first side, and then the second operator would take that off of the machine and turn it, and he would do the second side.

That required a minute and a half of welding time on each side.

Q. And how much was the total time?

A. The total time, from the time we would start—that is, from the time that we would take the wheel from the preheating furnace until we had actually finished the weld, or finished the wheel, and broke the wheel out of the fixture, would have consumed—or did consume approximately five minutes.

Q. Was there a time when hand-welding was used in the manufacture of this wheel?

A. Yes, sir; that was the first transition from the keyed bucket; the first transition was to the hand-welding
1050 operation.

Q. And how much time did it take to hand-weld one of these wheels?

A. Well, it took approximately four and a half hours, but they did, through various methods, and improving methods, and all that, cut that down to approximately one and a half hours per wheel.

Q. In this plant which you have described, how many machines and how many operators were used in the welding with Unionmelt welding?

A. On this production job, in making the wheels, there were four machines used, that is, four heads.

Q. And how many operators?

A. Well, there were four operators on each of two shifts.

Q. Or a total of eight operators?

A. In other words, a total of eight operators, yes, sir.

Q. And how much production per week was turned out with Unionmelt welding?

A. Oh, we were making between 1,000 and 1,200 wheels per week.

Q. What kind of labor did you require for the welding?

A. Well, on this particular job, it was not too
1051 highly skilled. As a matter of fact, that was one of the objects in trying to develop a weld of that type, because we did not have the type of people available, and neither did we have the time to train them to do this job, because it was a fussy job, and we did not have either the talent to draw from, nor the time to teach them to do this job.

As it was, we worked the method out in the laboratory, and merely gave the factory the procedures to follow, that we had worked out successfully in the laboratory.

Q. Was there any saving in cost effected by the use of the Unionmelt as against hand-welding?

A. Yes, sir; it amounted to approximately $5.00 a wheel; that is, it was cheaper by that much.

Mr. Fowler: You may cross-examine.

1052 *Cross-Examination by Mr. Stewart:*

Q. Mr. Morrissey, when did you receive a subpoena?

A. When?

Q. Yes, when.

A. Day before yesterday.

Q. And in the process—are you an electrical engineer?

A. No, sir.

Q. You have been in the welding business for some time?

A. Twenty-six years.

Q. You are familiar with arc-welding, hand arc-welding, and so forth?

A. Yes.

Q. In the practice of the Unionmelt process, is it not an electric arc that provides the heat for the melting of the metal?

A. I don't know that.

Q. You don't know that?

A. I don't know what it is.

Q. What does that?

A. Well, as near as I would be able to say, it would be the electrical current going through the wire.

Q. Going through the wire?

1053 A. Or down through your machine or through your head.

Q. Is there an arc down there underneath the head?

A. I don't know. I have not been able to see.

Q. Did you ever have a plate burn through that you were welding?

A. You mean to actually go through the plate, that is, penetration?

Q. Yes.

A. Yes.

Q. Did you see an arc?

A. I can't say I did. There was flux all over, and compound, whatever it was, melted. It would be pretty hard to say whether it was an arc or what it was.

Q. In doing what you say, it acted pretty similar to a cutting torch, in the end result.

A. I know that.

Q. You don't know, however, whether or not there was an electric arc involved or not, do you?

A. I would say no, I don't know definitely; not definitely enough to make a definite statement of that, no, sir.

Q. You don't know that there isn't an electric arc, do you?

A. No, sir.

1054 Mr. Stewart: That is all.

Mr. Fowler: Thank you, Mr. Morrissey.

The Court: For my information, are these so-called buckets separate as they are fitted there, and then the weld takes place, or are they together?

The Witness: No, they are separate, individual buckets. There is 144 of them in this wheel.

The Court: And the welding takes place as to each one separately, that is, they are not put together first?

The Witness: They are fitted together in this respect that the end of the bucket is ground out with a proper angle on it so that the 144 buckets are fitted in there very tight.

In fact, the girls that fitted them up had to actually pound them down there to get the top point of the fixture. Then with that in position, the inside diameter is ground out to fit, to allow this wheel to be inserted in there, and they are individual buckets.

The Court: That is the only question I have.

1055 The Witness: Is that all?

Mr. Fowler: That is all.

(Witness excused.)

Mr. Fowler: The plaintiff calls Mr. Cornwell.

ROSS EUGENE CORNWELL, called as a witness on behalf of the plaintiff, having been duly sworn, testified as follows:

Direct Examination by Mr. Fowler.

Q. Will you give us your name and business address?

A. Ross Eugene Cornwell; 30 East 42nd Street, New York City.

Q. Are you an officer of the plaintiff, the Linde Air Products Company?

A. I am.

Q. And what office do you hold?

A. Vice president.

Q. And how long have you been connected with Union Carbide and its subsidiaries?

A. Since 1923.

Q. Are you familiar with the patent in suit?

1056 A. I am.

Q. Now, I call your attention to 1933, and ask you if you saw any sample welds that were sent to you from San Francisco?

A. They were not sent to me personally; they were sent to the company, in February, the latter part of January or early part of February of 1933.

Q. And what did you do about those welds?

A. They were examined visually, and then sent to our laboratories for complete physical tests to determine the quality of the weld.

Q. Did there come a time when you went to San Francisco?

A. Yes.

Q. Could you tell us what you did there?

A. I was in San Francisco the latter part of April and the early part of May of 1933. At that time I contacted with Messrs. Jones, Kennedy and Roterimund, who had developed a process by which the welds had been made which we examined.

In view of the nature of the appearance of these welds and the speed at which the welds were alleged to have been made, we were particularly interested in the process which they had utilized in making these welds; and I talked

1057 to the three gentlemen many times regarding what they had done and how they made these welds.

Q. Did they give you some paper?

A. Yes, they did. After discussing this matter with them several times, they gave me a copy of the patent application as filed in the United States Patent Office.

1058 Q. When did you make your next trip out to San Francisco?

A. In the latter part of September of the same year.

Q. What did you do on that trip?

A. At that time they made a demonstration of the welding process which they were unable to do at my first visit, and following this welding demonstration we worked out a tentative—or I should better say, a deal for the acquisition of the process which they had developed.

Q. Can you tell us the facts about that demonstration?

A. They made a demonstration in Mr. Kennedy's shop. The first test was welding a one inch plate, and as I recall, that particular weld was made at around 1200 amperes, around 38 volts, and I believe about 6 or 7 inches a minute without any visual evidence of a welding operation taking place.

They made welds in one inch carbon steel and also in one inch cromansil steel, which is a special alloy steel. They also made some welds in thinner plate, demonstrated the process at higher speeds on thinner plates.

Q. At that time what connection did Linde Air

1059 Products have with the electric-welding industry?

A. None.

Q. Did you personally have any connection with welding prior to that time?

A. Yes. Phad, in many ways. My first contact with welding was in 1918, with acetylene welding. Prior to my going to the University, and while I was in the University, I did additional work on welding.

Following my graduation I was closely associated with acetyiene welding and also electric welding as it was developed in those years between 1923 and 1930.

Q. At that time Linde Air Products Company was a subsidiary of Union Carbide and Carbon Corporation, was it not?

A. That is correct.

Q. And also Union Carbide and Carbon Research Laboratories, Inc. was a subsidiary, was it not?

A. It was.

Q. What activity did the Linde Company follow after it made its agreement with the inventors?

A. After we made the agreement with the inventors, we made arrangements with Mr. Kennedy to come to New
York, where we had set up a special welding installa-
1060 tion in Long Island City.

As a matter of fact, the welding head and travel equipment had been shipped from Mr. Kennedy's shop in California, near San Francisco, and following the original tests, or following the initial tests that were made at Long Island City, when the test equipment was set up, we continued to develop and explore the various voltages, and currents, and various types of equipment required to apply the process industrially to the different fields and different types of application.

Mr. Fowler: I ask that this book be marked as Plaintiff's Exhibit No. 210 for identification.

Mr. Van Duzer: May I see it, please.

Mr. Fowler: Certainly.

(Whereupon said book was marked Plaintiff's Exhibit No. 210 for identification.)

By Mr. Fowler:

Q. Mr. Cornwell, can you tell us what this book, which has been marked as Plaintiff's Exhibit 210 for identification, is?

A. Yes, sir, it is a book entitled Unionmelt Weld-
1061 ing which discloses the method of operation of the process, showing the type of welds that can be made, how the process operates, and which gives the general welding conditions for certain general applications as well as certain types of general set ups and electrical equipment required to carry out the process.

That was published in 1938.

Mr. Fowler: I offer Plaintiff's Exhibit No. 210 for identification in evidence.

Mr. Van Duzer: No objection.

The Court: Admitted.

(Whereupon said PLAINTIFF'S EXHIBIT NO. 210 was admitted in evidence.)

Mr. Fowler: I ask that this book, Unionmelt Welding Operators Manual, First Edition, be marked as Plaintiff's Exhibit No. 211 for identification.

Does counsel care to see it?

Mr. Van Duzer: No, I have seen that.

(Whereupon said book was marked Plaintiff's Exhibit No. 211 for identification.)

1062 By Mr. Fowler:

Q. Mr. Cornwell will you please state what this book is, Plaintiff's Exhibit 211 for identification?

A. This is a book entitled Unionmelt Welding Operators Manual, which was published, I believe, in 1945 or 1946—in 1945.

It gives general instructions pertaining to the operation of the process, the currents to be used, the various bevels and types of bevels, current, voltage and speeds to be used for general types of welds.

Mr. Fowler: I offer Plaintiff's Exhibit 211 for identification in evidence.

Mr. Van Duzer: No objection.

The Court: Admitted.

(Whereupon said PLAINTIFF'S EXHIBIT NO. 211 was admitted in evidence.)

By Mr. Fowler:

Q. Can you tell us whether or not the Linde Air Products Company designed a new welding head?

A. Yes, sir, they did; at the time this process came to our attention, there was no equipment suitable for
1063 handling the currents and sizes of electrodes required by this process, and it was necessary, therefore, to develop a special welding head that would handle the large current and large rods required for this particular type of welding.

Q. Can you tell us anything about the training of personnel?

A. Well, with the acquisition of the process, with the expectation of exploiting it, it was necessary to train a certain number of personnel, in order that they would be familiar with the process, so that they could acquaint prospective users and users with the application of the process, and how it could best be used.

Q. Now, coming to the Unionmelt welding composition: how was your company able to acquire that, or to obtain it?

A. The Unionmelt welding composition, being a fused material, was produced by one of our associated companies in an electric furnace.

It was necessary, naturally, to develop special equipment for its production, bagging and handling.

Q. When was the first factory installation of the Unionmelt welding process?

1064 A. The first factory installation of the Unionmelt welding process was made in the plant of the Consolidated Steel Company, at Los Angeles, California, in the latter part of the year 1934.

I might say that there was a previous experimental installation, as you might call it, made at the Lukens Steel Company at Coatesville, Pennsylvania, for a very special application of the welding.

Q. What was the application at the Consolidated Steel Company plant?

A. At the Consolidated Steel Company, the process was installed there primarily for the welding of pipe and pressure vessels which were currently being produced by the Consolidated Steel Company.

The process was first used, commercially, in connection with producing pipe for the Malheur project, which was 80 inches in diameter, with a wall thickness of one-half inch, for installation in Idaho.

That was made in the early part, or the middle part of the year 1935.

Q. And did you personally go out there at that time?

A. Yes, sir, I was there on many occasions during that period.

1065 Q. What results were obtained by that application?

A. Exceptionally good results were obtained. As a matter of fact, they obtained higher speeds than they had ever been able to obtain before, and I think it was universally accepted as a better quality of weld than had ever been obtained before.

They were able to produce the pipe at a much faster speed than they had been able to do prior to that time.

Q. What about costs?

A. The actual welding costs were considerably lower than what they had been previously experiencing.

1066 Q. Were some other factory installations made shortly thereafter?

A. Yes. The installation made following that was in the Taylor Pipe & Forge plant in Chicago for welding pipe penstocks of the fire tube for Scotch marine boilers and similar welding operations.

Q. What were the requirements there as to quality of weld?

A. The quality there had to be exceptionally high due

to the fact that the tube for the Scotch marine boiler had to be corrugated after it was produced, which was a very severe punishment to not only the plate metal, but to the weld metal.

Also, with respect to the penstocks, they were making Vanstone flanges on the end of the penstocks, which required exceptionally good weld quality to prevent cracking.

Q. Can you tell the Court what penstocks are?

A. A penstock is an unusually large diameter pipe used for transmitting water from a lake or something of that character to a water turbine for the generation of power.

Q. Was some other factory installation made shortly thereafter?

1067 A. The next one following that was the Electro-Motive Company at LaGrange, Illinois. Electro-Motive at that time was a subsidiary of General Motors and they were inaugurating a new type of engine, utilizing a Diesel engine for railway service instead of the common steam engine.

Their immediate problem at that time was producing frames for the Diesel engine, because the cast frames they could obtain would not fulfill all the specifications required for an engine of that type.

The bed of these engines—or the frame, I should say, was made out of four or four and a half inch plate which was welded down the middle, because they could not get a plate large enough for the entire bed of the locomotive, and to weld the bed they had to weld stiffeners to strengthen the plate to support the Diesel engine.

Q. How many passes were used on that weld?

A. On the four and a half inch plate they made two passes, one from each side.

Q. Can you tell us the facts as to that two-pass procedure?

A. In that particular case the plate was beveled
1068 with a double Vee, with a nose in the center of the plate, and the first pass was made, the weld penetrated into the nose of the plate, and the plate was then turned over and a second pass made to almost, or to meet the first pass.

Q. Was there some advantage in the two-pass procedure?

A. Very definitely. In the case of that operation it

would have been necessary to install very heavy electrical equipment to furnish adequate current to weld the plate in one pass. It also simplified their equipment in that if they had made the four and a half inch weld in one pass, the backing-up or the copper bar we use to back the weld, would have been rather difficult to hold in place, so by welding heavy plate from both sides it eliminated that difficulty.

It also minimized the investment in the equipment and the resulting welding speed was practically the same, even with the two-pass method as it would have been if they had done it with one pass.

Q. Aside from that particular application, and speaking generally, is there some other advantage in the two-pass procedure as against the one-pass procedure?

A. Yes. There are several advantages to the two-
1069 pass procedure. I think one of the important ones is the one I mentioned, namely, that it avoids the necessity of using a backing-up bar.

Two, it does avoid the installation of excessively heavy electrical equipment. Another one is that it minimizes the distortion that you might get in welding from one side in case you did not get full penetration.

In certain types of welds it is imperative that they have complete penetration. I mean by that, that there is no crack—I mean, no unfused portion at the root of the weld for a crack to start. The two-pass method eliminates that particular difficulty, which is probably the most important from the standpoint of the characteristic of the weld. The others pertain only to the type of equipment and ease of producing the resultant weld.

Q. Under actual factory conditions, are there some factors that effect the depth of penetration? Is it always possible to get exactly the right degree of penetration?

A. That is perhaps a little difficult, because the carbon content of steel varies, and there is a change in the melting point; the source of the current may vary some-
1070 what, making it difficult to control the voltage or current. A number of factors enter into it.

I think perhaps the composition of the steel is probably —I wouldn't say it is the most important. Also another factor would be in machining the plates, if there is any difference in the bevel, or it is improperly beveled, it would reflect itself more in a single Vee than a double Vee weld.

Q. Do you recall what was the next installation of the Unionmelt process?

A. I believe the next one following the one at Electro-Motive was the installation at Sun Shipbuilding & Drydock, at Chester, Pennsylvania.

Q. And what was the status of the Unionmelt welding process after that installation, particularly with respect to shipbuilding?

A. That was the first introduction of the Unionmelt process to the welding of ships.

They were interested at that time in producing an all-welded tanker, and were trying to fabricate as large sections as they could for assembling on the ways, and this practice lent itself to this particular operation in that
1071 it is easier to weld the stiffeners to the bulkhead and to make large assembly sections without the usual distortion accompanying hand-welding.

Q. Did any public agencies accept the process?

A. Yes. At that time, before they were permitted to use that process in the welding of ships, it had to be approved by the American Bureau of Ships, which was the inspection agency, and also approved by Lloyds in England, because I believe they were the insurance agency.

Q. Coming to 1936 were there further installations?

A. Yes, there were additional installations at Griscom-Russell, Massillon, Ohio, and American Locomotive at Dunkirk, and American Rolling Mills at Middletown, Ohio.

Q. What was the use made at Middletown?

A. The welding of spiral pipe.

Q. What effect did that have on the production of pipe?

A. Actually when we placed the welding with the Unionmelt welding process, their output more than trebled, without increasing the investment, I should say by using the same equipment they had been previously using; and
1072 the number of patches or leakers that they had with their other welding process were practically eliminated.

Q. Now, what about the fabrication of pressure vessels?

A. The fabrication of pressure vessels was probably one of the most important fields of welding, from the standpoint of quality of the weld, and the Unionmelt process was adapted to the welding of pressure vessels early in the application of the process.

As a matter of fact, Consolidated Steel, shortly after they made their first water line, started welding pressure vessels. Griscom-Russell also welded pressure vessels; and it was

later adopted by the outstanding manufacturers of pressure vessels in the country.

Q. Were there any code requirements in that respect?

A. Yes. It had to meet the various codes, such as ASME and API codes.

Q. Was there any litigation in connection with this patent?

A. Yes.

Q. Would you tell us about that?

A. At the time the inventors developed their process at the plant of Western Pipe & Steel, they did not work
1073 out an arrangement with Western Pipe, and Western Pipe continued to utilize the process that had been developed in their plant; and when the patent issued in June of 1936, we filed suit against the Western Pipe & Steel Company.

Q. In what court?

A. San Francisco.

Q. Who were the parties to the suit?

A. Western Pipe & Steel, and Linde Air Products Company.

Mr. Fowler: I ask that this paper be marked for identification as Plaintiff's Exhibit 212.

(Whereupon said document was marked Plaintiff's Exhibit 212 for identification.)

Mr. Fowler: Have you seen it?

Mr. Van Duzer: Yes, we have.

Mr. Fowler: I offer the paper in evidence.

Mr. Van Duzer: We have no objection to this, your Honor. This is the final decree in that litigation. It was admitted, I think, that it was entered by consent.

1074 As long as it is not contended that the patents were adjudicated in any sense in that case, we have no objection.

Mr. Fowler: It is a certified copy of the decree in the suit brought in the United States District Court, Southern District of California, Central Division.

Mr. Van Duzer: You do agree that there was a settlement, and that is a consent decree, and the patent was not adjudicated?

Mr. Fowler: I agree it was entered on consent of the parties—

Mr. Van Duzer: Unless the admission goes the whole way, we object to it.

Mr. Fowler: It represents the result of the only prior litigation concerning the validity of the patent.

Mr. Van Duzer: What do you claim for it?

Mr. Fowler: I claim it represents the result of the only litigation, prior litigation, on the validity of the patent.

The Court: Isn't what you are both talking about an inference as to what flows from that?

1075 Mr. Van Duzer: Yes, your Honor, but we have been over that so many times, and never until now, except in the very early stages, has there been any intimation whatever that anything was really claimed for this.

I assume we both know it was a consent decree, that there was no adjudication, and it doesn't establish anything.

Mr. Fowler: As Mr. Cahill said in the opening—

Mr. Van Duzer: If it is offered on that basis, we have no objection.

Mr. Fowler: As Mr. Cahill said in the opening of the case, when Mr. Byron interjected, Mr. Cahill said, "The government at least contends a consent decree means something and has some effect", and we believe this consent decree is admissible.

1076 Mr. Van Duzer: Well, I do not understand the reference to the Government.

Mr. Fowler: It is merely an illustrative reference.

Mr. Van Duzer: Well, I think that the Defendants are entitled, may it please the Court, to know whether or not the Plaintiff claims anything for this decree, other than the fact there was a settlement of the lawsuit.

Mr. Fowler: I am not arguing at this time, your Honor, as to the weight that is to be given the evidence. I am merely saying that the evidence is admissible.

The Court: The document is received in evidence, and the parties may state for the record, they will have an opportunity to state for the record, if they have not already fully stated them, their views as to what inferences may properly and legitimately be drawn therefrom.

1077 (Whereupon said PLAINTIFF'S EXHIBIT NO. 212 was admitted in evidence.)

By Mr. Fowler:

Q. Now, Mr. Cornwell, in connection with the application of the Unionmelt process at Electro-Motive; I am not quite sure whether you mentioned the amperage that was used.

Could you tell us that?

A. No, sir. I did not state that. As I recall it, 3,000 amperes were used, in making a pass on each side of the 4½ inch plate.

Q. Now, coming to the Western Pipe and Steel Company: did they take a license?

A. Yes.

Q. And have they paid royalties for the use of the Unionmelt process?

A. They have.

Q. Was there a public announcement of the Unionmelt process?

A. Yes, sir, there was a public announcement of the Unionmelt process made at the Metal Show, in De-
1078 troit, Michigan, in the year 1938.

That was accompanied by a public demonstration of the use of the process, and the release of the book which was introduced here a little while ago as Plaintiff's Exhibit No. 210, I believe.

Q. What is the total number of licensees under the Unionmelt process?

A. The total number of licensees under the Unionmelt process is between, I would say, 740 and 750.

Q. And what is the total amount of royalties that have been paid for the Unionmelt process?

A. In round figures, six million dollars.

Q. Can you tell us how many pounds of welding rod have been deposited by the use of the process?

A. Around approximately 105,000,000 pounds.

Q. Now, so that we may be a little better able to visualize that, can you convert that into a number of miles of welding, taking, say, a half-inch plate?

A. If that weld metal had been used in making half-inch butt welds, the length of the weld would have been 50,000 miles—approximately 50,000 miles.

Q. I am not sure, Mr. Cornwell, whether you told us the story about the use of the process in connection with
1079 spiral pipe, the welding of spiral pipe.

A. Spiral pipe is produced by taking skelp, which you might say is sheet steel, on a roll of a definite width, and that sheet steel is fed into a machine which forms it into pipe.

Instead of having the weld longitudinally of the pipe, as you do in normal pipe welding, the welding is spiral. In other words, if you take a piece of paper, and turn it this

way (Indicating), it will indicate that the weld will go around the pipe.

That is done automatically; that is, the skelp is fed into the automatic machine, and the pipe is automatically formed, and as the pipe is formed, it is welded.

The welding operation is not stopped. After a certain length of pipe is made, it is automatically cut off, but the machine is continuous in operation.

That has several advantages over producing pipe by other means, namely, that they get some advantage in the increased strength by the pipe being spiral; and also fewer man hours are required in making the pipe, because
1080 it is only handled the one time, and it is fed continuously through the machines.

The machines are capable of making varying diameters of pipe, of varying plate thicknesses.

That is one of the methods that was used in making the invasion piping that was used during the war.

Q. Did that have some effect also on the amount of production, as compared with prior methods?

A. As I mentioned a few moments ago, when we substituted the Unionmelt process for the method that they were at that time using at Middletown, we more than trebled the output per machine, or per hour.

Since that time the speeds have been increased further, and I would say at the present time that the speeds are in a magnitude of five to six times as fast as they were at the time we started there.

That increase in speed since we first went there has been primarily due to mechanical improvements in the machine itself, that is, the spiral pipe machine, because originally it was not made to operate and produce pipe as fast as the Unionmelt process was capable of welding it.

1081 There is a similar installation on the West Coast, at the California Corrugated Culvert Company, where they make what is called irrigation pipe for the west coast.

They use there the same process that is utilized at Middletown; that is, the machines, the spiral pipe machines are the same, except that they usually run a lighter wall pipe, because irrigation pipe has to be light in weight, in order to be mobile.

The increase in speed at that point, I would say, was even greater than it was at Middletown.

They had previously used, at Berkeley, where the plant

of the California Corrugated Culvert Company is located—or they had previously tried to use, oxyacetylene welding, and then they tried the bare electrode welding, and they also tried the carbon arc process.

They are using the Unionmelt process there at the present time, which was adopted in the latter part of 1936 or the early part of 1937; and the speed there has been increased to between 120 to 140 inches a minute, on 12-
1082 gauge sheets; whereas the speed of welding prior to that time was in the magnitude of somewhere around 20 inches to 24 inches a minute.

1083 They also had an excessive amount of patching with the original methods they were using, and today it is not unusual to make a mile of pipe without a single pin hole leak.

Q. Give us the names of some representative licensees in various fields. First take shipbuilding. We have already heard about Sun Shipbuilding. What are some of the others which use the Unionmelt welding process?

1084 The Witness: The most important shipbuilding companies that employ the Unionmelt welding process are Sun Shipbuilding & Drydock, at Chester. Bethlehem Shipbuilding at their various plants. Newport News Shipbuilding & Drydock Company. All of the Kaiser yards. Alabama Drydock. I think that—I should add New York Shipbuilding and Federal Shipbuilding.

By Mr. Fowler:

Q. Take pressure vessels: there are some of us, at least, who never knew what a pressure vessel was until we got into this case. What is a pressure vessel company?

A. What is a pressure vessel company?

Q. Yes.

A. A pressure vessel company is one which manufactures pressure vessels which may be used for low pressures, or may be used for high pressures, such as cracking stills in oil refineries, or boilers for the purposes of steam locomotives, ships, and all types of vessels where there is internal pressure in excess of relatively low pressure.

Q. What are some of the leading companies in that
1085 industry that use your process?

A. The leading ones in that industry would be A. O. Smith Corporation at Milwaukee. Babcock & Wilcox at Barberton, Ohio, and their other plants. M. W. Kellogg Company. C. F. Braun Company.

Q. Does the A. O. Smith Corporation also have other applications for your process?

A. Oh, yes. They have many other applications in addition to pressure vessels. They produce hot water tanks, butane tanks and many other applications that would not be classed strictly as pressure vessels. During the war they used the Unionmelt process on making large bombs that were used, which had a wall thickness of, as I recall it, five or five and a half inches.

Q. Coming to the railroad equipment field what are some of the companies that use your process?

A. The Pullman Standard. General American Tank Car. American Locomotive. Some of the railroad companies themselves.

Q. In the automotive equipment field what are some licensees?

A. Clark Equipment Company. Motor Wheel Corporation. Midland Steel Products Company. American Metal Products Company.

1086 Q. Have any steel companies taken licenses?

A. Several of them. I mentioned American Rolling Mills, Bethlehem Steel, Inland Steel, National Tube Company, American Bridge Company.

Q. And what about general manufacturing companies?

A. Those are very numerous. I think some of the outstanding ones, with a diversity of products, would be Allis-Chalmers, Chicago Bridge and Iron, International Harvester, Caterpillar Tractor. I think those are the most important ones.

Q. Are there any companies that are interested in the electrical equipment for welding equipment which hold licenses?

A. Oh, yes. I neglected to mention those in that field. That would include General Electric Company and Westinghouse Company, and Harnischfeger.

The Court: Where are they located?

The Witness: Milwaukee.

Mr. Fowler: I ask that this reel of motion picture film be marked for identification as Plaintiff's Exhibit 213.

1087 (Whereupon said reel was marked Plaintiff's Exhibit No. 213 for identification.)

By Mr. Fowler:

Q. Referring to Plaintiff's Exhibit 213 for identification. I will ask you if you are well acquainted with the pictures shown on that reel.

A. Yes, I am. The pictures shown on this reel were made showing fabrication or weld of center sills for railway cars and center sills for Pullman cars, and fabrication of subassemblies at Sun Shipbuilding.

Q. And have you been in all the places that are portrayed on this picture?

A. I have been, and I have seen all these operations.

Q. And does it accurately portray those scenes?

A. It does.

Mr. Fowler: I offer the exhibit.

Mr. Van Duzer: No objection.

The Court: Admitted.

(Whereupon said reel, PLAINTIFF'S EXHIBIT NO. 213 was admitted in evidence.)

1088 Q. Coming now to the licensing policy of the Linde Air Products Company with respect to the Unionmelt process, will you tell us what that policy is?

A. Our policy is to grant a license to the process to anyone that has a use for it, under a standard license 1089 agreement.

Q. Are you familiar with the procedure adopted by the United States Patent Office in 1945 with respect to the registration of patents for licensing?

A. I am.

Mr. Fowler: I ask that this paper be marked Plaintiff's Exhibit 214 for identification.

(Whereupon said document was marked Plaintiff's Exhibit No. 214 for identification.)

Mr. Fowler: I ask if the other side has any objection to the admission of this document?

Mr. Van Duzer: Oh, no, not at all.

Mr. Fowler: I offer the exhibit.

The Court: It may be admitted.

(Whereupon said document, PLAINTIFF'S EXHIBIT NO. 214 was admitted in evidence.)

By Mr. Fowler:

Q. Has the Linde Company availed itself of the procedure adopted by the Patent Office, as shown by that exhibit?

1090 A. Yes, it has.

Mr. Fowler: This paper was Defendants' Exhibit 33 on the depositions, and I ask that it be marked for identification as Plaintiff's Exhibit 215.

(Whereupon said document was marked Plaintiff's Exhibit No. 215 for identification.)

Mr. Fowler: You have a copy, Mr. Stewart?

Mr. Stewart: Yes.

By Mr. Fowler:

Q. Are you familiar with Plaintiff's Exhibit 215 for identification?

A. Yes.

Q. And what is that paper?

A. It is our standard Unionmelt welding process license agreement, which is being currently offered.

Mr. Fowler: I offer the paper in evidence.

Mr. Van Duzer: No objection.

The Court: Admitted.

(Whereupon the document, PLAINTIFF'S EXHIBIT NO. 215, was admitted in evidence.)

1091 Mr. Van Duzer: Do you care to state, Mr. Fowler, how long that particular form has been in use, and also, at the same time, offer its predecessors?

Mr. Fowler: Yes, we are about to do that.

By Mr. Fowler:

Q. To answer Mr. Van Duzer's question, Mr. Cornwell, is it correct to state that the current form of license agreement just admitted in evidence was adopted in May, 1946?

The Witness: May I see it, please?

(Document handed to the witness.)

The Witness: About that time, yes.

Mr. Van Duzer: Well, that is subsequent to the filing of this suit, Mr. Fowler. I think you better get the ones in that were in effect before the suit was filed.

Mr. Fowler: I am just about to offer all of the forms of license agreement used by the Linde Air Products Company with respect to the Unionmelt process; and if the De-

1092 fendants have no objection, I will have them marked in evidence.

Mr. Van Duzer: None at all.

Mr. Fowler: I would suggest that this list which is with the forms of agreement be itself marked in evidence as a part of the exhibit.

By Mr. Fowler:

Q. I will ask the witness if all of these papers, plus the list on top of them, represents the forms of licenses used

by the Linde Air Products Company with respect to the Unionmelt process, and if the list correctly indicates the dates on which the various forms were adopted and were superseded by later forms.

1093 A. They do.

Mr. Fowler: I offer the papers in evidence.

Mr. Stewart: No objection. Mr. Becker assures me that they are the same.

The Court: Admitted. How are you going to mark these papers? Are you going to give them separate numbers, or different letters, or how?

Mr. Fowler: I suggest, if your Honor please, that the list be marked as Plaintiff's Exhibit No. 216-A, and then the various forms following be marked as Plaintiff's Exhibits 216-B, 216-C, and so on, using the next consecutive letter for each one.

The Court: They may be so marked.

(Whereupon the said papers were marked respectively PLAINTIFF'S EXHIBITS 216-A to 216-S and admitted in evidence.)

By Mr. Fowler:

Q. Under these forms of licenses, Mr. Cornwell, the royalties are based upon the amount of rod used in the process; is that correct?

1094 A. They are based upon the amount of rod that is deposited by the process.

Q. Will you please tell us the facts which led the company to adopt that measure?

A. In searching for a method of measuring the extent to which the process was used, the only logical measuring stick that appeared to be feasible was to base it on the amount of rod that was deposited, because that is something that can easily be determined, since there is no spatter loss, or loss of that character.

If the licenses had been based upon the length of the welds, plate thickness would have come into the picture, and would have made a very difficult accounting problem.

Therefore we selected the amount of rod deposited

1095 by the process as the measuring stick, to measure to what extent the process had been used, and it is an accurate measuring stick, and one that is very readily determined and which eliminates—or at least which minimizes the amount of accounting required by our licensees.

to report the amount, or the extent to which the process has been used.

Q. Have you personally participated in the negotiation of licenses?

A. Oh, yes.

Q. And in those negotiations, is the attention of the prospective licensees directed to any patents?

A. Usually it is, yes, sir, because when you are discussing a license with anyone, they are naturally interested in what kind of a license they are getting, and under what patents they are being licensed; so we always direct their attention to the patents in question.

As a matter of fact, those are all listed in the license agreement.

1098 Mr. Fowler: I am taking the printed form of the license agreement which was in effect at the time this suit was filed. It was marked as Defendants' Exhibit
1099 32 on the depositions, but it has not yet been marked by the Reporter here.

By Mr. Fowler:

Q. I ask you, Mr. Cornwell, if you can give us a brief word as to the various patents which are listed in that paper?

Mr. Van Duzer: Well, I object to the form of the question. They are identified by number and he can tell your Honor what they are. To ask for a brief word calls for some sort of a dissertation about them.

By Mr. Fowler:

Q. Tell us what they are.

A. You mean, as a group?

Q. No. Take each one. What is the first one listed?

A. The first patent listed is the Robinoff Patent.

Q. What is the next patent listed?

A. The Jones-Kennedy-Rotermund patent.

Q. The patent in suit here?

A. The patent in suit.

Q. Can you take the next one?

A. I could not identify the rest of them by the numbers.

1100 Q. Can you tell us generally with respect to the other patents listed in that agreement, what they are and what they cover?

A. It is rather difficult to cover each one of them specif-

ically, but I would say that they cover various phases of the application of the Unionmelt welding process. Some of them cover types of backing up. Some of them cover various and sundry things used in connection with the process itself. Some companies would use all of them and some would not.

Q. What is the expiration date of the current form of license agreement?

A. The expiration date of the current form of license agreement is June 9, 1953. I believe that is the date.

Q. Why was that date selected?

A. That is the expiration date of the Jones patent, No. 2,043,960.

Q. Now, I ask you in connection with your license policy whether there is any provision with respect to the use of the welding material furnished by the Linde Company or sold by it at the present time?

1101 The Witness: No.

Mr. Van Duzer: I take it you mean at the time the suit was started.

Mr. Fowler: I will amend my question to make it read, at the time the suit was started.

The Witness: The answer is "No".

By Mr. Fowler:

Q. Is your answer the same as to welding rod?

A. My answer is the same.

Q. Is it the same as to any equipment or material sold by the Linde Air Products Company?

A. It is the same.

Q. Have you advised the Defendant in this suit, the Lincoln Electric Company, in that connection what your policy is?

A. We have.

Mr. Fowler: I ask that this letter be marked for identification as Plaintiff's Exhibit No. 217.

1102 (Whereupon said document was marked Plaintiff's Exhibit No. 217 for identification.)

Mr. Van Duzer: Is that part of the series of correspondence between Mr. Cornwell and Mr. Lincoln?

Mr. Fowler: Yes.

Mr. Van Duzer: Why don't you offer them all?

Mr. Fowler: We do not have the others available right here at the moment. We will be happy to have it all go in.

Mr. Van Duzer: We can do it.

By Mr. Fowler:

Q. Is that a letter which you wrote to Mr. James F. Lincoln, the president of the Lincoln Electric Company?

A. It is a photostatic copy of the letter I wrote him.

Mr. Fowler: I offer the exhibit in evidence.

Mr. Van Duzer: No objection.

The Court: It is admitted.

1103 (Whereupon said document, PLAINTIFF'S EXHIBIT NO. 217 was admitted in evidence.)

Mr. Fowler: This is a letter written by Mr. Cornwell to Mr. Lincoln under date of September 10, 1943, and I wish to read this part of it:

"We have repeatedly told our licensees that they are perfectly free to buy any materials or equipment they desire from you or any other manufacturer, and as far as that goes we have gone even further than that and recommended that they buy such equipment and materials, if they felt they were superior to what we are offering for sale."

I should next like to comply with Mr. Van Duzer's suggestion and offer the various forms of rod contracts which were used in the sale of rod by Linde Air Products Company.

Mr. Van Duzer: That is the complete list, is it, Mr. Fowler?

Mr. Fowler: Yes.

Mr. Van Duzer: No objection, of course.

1104 The Court: They may be admitted.

(Whereupon said documents were marked PLAINTIFF'S EXHIBITS NOS. 218, 218-A to 218-G, both inclusive, and admitted in evidence.)

Mr. Fowler: These will be Plaintiff's Exhibits 218, A, B, C and so forth. These papers were marked on the depositions as Defendants' Exhibits 87-A to and including 87-G.

Mr. Van Duzer: Mr. Fowler, I cannot require you to do it at all, but to complete the story so far as we can go at the present moment with respect to the license contracts and the rod contracts, would you care to read pages 283 and 284 of Mr. Cornwell's deposition and particularly Mr. Becker's concessions?

1105 Mr. Fowler: I would be very happy to have Mr. Van Duzer read it in, while I get a drink of water.

Mr. Van Duzer: I shall be very happy to do so. The question was put to Mr. Cornwell as follows:

"Q. I wish that you would reply to Mr. Becker—and perhaps you had better listen to this, Mr. Becker—so that he can furnish us without customers' names, a tabulation or a list showing the date, relationship between the license contracts"—

The Court: Who is saying this to whom, now?

Mr. Van Duzer: This is Mr. Van Duzer inquiring of Mr. Cornwell.

The Court: Oh, yes.

Mr. Van Duzer: I continue:

"—and the rod contracts in the case of each licensee. Will you have such a study made and submit it to Mr. Becker?"

Then Mr. Becker interjected:

"Mr. Becker: We have checked that record, Mr. Van Duzer, and we can inform you at this time that the
1106 license contracts and rod contracts in about ten per cent of the instances, where we have rod contracts, were executed the same day.

"Mr. Van Duzer: Has that been true"—

This question was directed to Mr. Becker. "—all through the period, or are the ten per cent the earlier ones, or can't you answer that?

"Mr. Becker: This is an over-all statement of the whole period.

"Mr. Van Duzer: And some of the recent ones, then, are similarly dated the same day as well as the earlier ones?

"Mr. Becker: We have made no check as to week by week or month by month. It is the over-all total.

"Mr. Van Duzer: You haven't weighted it to see whether there was a change of policy?

"Mr. Becker: We have not, no."

Then the question was directed to Mr. Cornwell:

"Q. And are some of these ten per cent contracts that were executed the same day still outstanding and in
1107 effect?

"A. I cannot say whether that is true, but I believe that to be the case, that some of them are."

Now at that point Mr. Van Duzer requested Mr. Becker to answer that definitely; and later I think it was answered

definitely, that some were still in effect when the deposition was taken.

Mr. Becker: Would you please read into the record, Mr. Van Duzer, that portion of my letter which I later wrote to you, covering that point.

Mr. Van Duzer: I will let you read it.

Mr. Becker: Very well.

Mr. Van Duzer: Of course that should go in, Mr. Becker. I might say, if your Honor please, that the date of the deposition was October 4, 1946.

Mr. Becker: If the Court please, on November the 14th, 1946, I wrote to Mr. Van Duzer, enclosing a set of rod contracts, as introduced in evidence here today.

After specifying the various forms, as they are
1108 here specified in the record, I further stated:

"As you were informed at the adjourned deposition of Mr. Cornwell (transcript p. 283), in about ten per cent of the cases where Unionmelt licensees have contracts for the purchase of Oxweld rod for Unionmelt welding, the date of execution of the license contract and the rod contract is the same.

"We wish to call your attention to the fact that this does not indicate that the contracts were executed simultaneously, because in some cases the license agreement and the rod contract were signed by different individuals on behalf of the licensee/purchaser, and in no instance was a contract finally executed on behalf of The Linde Air Products Company until it had been accepted, in the case of license agreements, by Linde's New York office, and in the case of rod contracts, by the appropriate Linde division office.

"Mr. Van Duzer further inquired (transcript, pp. 283-294) as to whether some of the rod contracts having
1109 the same date of execution as corresponding license agreements are still outstanding and in effect. Our answer is in the affirmative."

That is the end of the quotation.

By Mr. Fowler:

Q. Now, Mr. Cornwell, the patent in this suit covers a welding process, and it also covers a welding composition, and these earlier forms of license agreement which have been introduced in evidence here show that the license to use the process was to be limited, so that the licensee could

use it with, and only with, the composition described in and covered by the patent.

I would like to have you tell us any facts that led up to the adoption of this provision of those earlier license agreements.

A. At the time we began our commercial exploitation of the Unionmelt process, and found people, like, for example, Consolidated Steel in particular, who were interested in its utilization, they were very materially concerned about being able to obtain the Unionmelt powder, or flux, if they went ahead and made a reasonable investment in their plant.

Inasmuch as there was no other manufacturer at
1110 that time who was making this product, and they wanted to have a definite source of supply of the material, that was included in the license agreement.

Also, due to the fact that they would make this investment, and we would make a similar investment to supply Unionmelt to them for a definite period, we made a commitment that they purchase this material, or only use this material when purchased from us, with the process at that time.

Q. Now, when was this limitation upon the use of the process entirely abandoned?

A. I believe it was in 1938.

1111 Q. And when did the Lincolnweld flux first come on the market?

A. In 1942, as far as I know.

Q. Now, coming back to the matter of negotiating with prospective licensees, would you tell us how you went about the negotiation of a license?

A. Well, in the early days, before the Unionmelt process became generally known, the first step, of course, was to familiarize the prospective licensee with the method of the process.

That might necessitate making demonstrations for him in our laboratory, or it might mean that we would do some special welding on the particular application that he had in mind, to be sure that the process was applicable to his particular application.

And of course, during that procedure the patent phase of the license agreement was naturally considered very carefully.

Q. What kinds of problems did you run up against in negotiating with prospective licensees?

1112 The Witness: May I ask at what time?

By Mr. Fowler:

Q. At any time. When you went out to a new prospective licensee, what did you have to overcome to get him to take a license and use the process?

A. Well, first you had to prove beyond any question of a doubt that the process would be more economical than the one he was using,—the atomic, or metallic arc welding, or carbon arc welding, or, in some cases, flash welding

1113 or resistance welding or even spotwelding. In other words, you had to establish that the adoption of the process would be an economical advantage to the prospective licensee.

Q. Did you find there were other companies in the welding industry?

A. Oh, we found there were many companies in the welding industry.

Q. Did you have any competition with those companies in selling your process?

A. Naturally we did, because these various companies were marketing certain processes that I mentioned,—the atomic welding, various types of hand electrodes, even automatic coated electric equipment and flash welding equipment, resistance welding equipment; and the competition, of course, was very keen, but we were able to establish a very decided saving over what they could do with the other processes, not only from the standpoint of saving in the actual welding operation itself, but to increase the output of the plant and the probability of them doing certain kinds of welding they couldn't do with the equipment they were then using.

Q. What kind of jobs were suitable for the Unionmelt process?

1114 A. The ones most suitable for the process were naturally those of a repetitive character.

I mentioned the spiral pipe welding as a very important application. Any repetitive welding on plate thicknesses from a very thin gauge of, I would say, 16 or 18 to very thick plates.

Where you have repetitive application,—for example, the production of rear axle housings, for automobiles and

trucks; the casings for refrigerators; small tanks, such as butane tanks that are used for the storage of butane for cooking, supplying heat for cooking; and hot water heaters for water heating systems; any type of operation that lends itself to repetitive use, where it can be mechanized to accomplish.

That is also true with pressure vessel welding, and things of that character.

Q. Is there some general limitation on the use of Unionmelt process?

A. The primary limitation of the process is that the welding must be done in a down position. It cannot be done in a vertical or overhead position—it can be done in a slightly inclined position, but is primarily designed to weld in a down position.

1115 Q. Are there some jobs where hand welding has advantages?

A. Oh, yes.

Q. Can you tell us about that?

A. Where the length of the weld is very short, where it cannot be adapted to mechanization, where it is overhead welding or vertical welding, or in some places where it is not accessible for automatic equipment.

Q. And is all of that especially true in some phases of ship construction?

A. That is true. There is a large percentage in the ship construction that cannot be done with automatic welding.

Q. And in the pressure vessel industry, are there some jobs where the advantage is in favor of the hand welding?

A. No, I don't know of a single instance where that would be the case, unless there was some small pressure shop that didn't have enough business to justify spending the money for an automatic setup.

Q. Well, in a big pressure vessel shop, has Unionmelt entirely superseded hand welding?

1116 A. No, it has not. And if you speak of pressure vessels as the container only, the entire welding can be done by Unionmelt process; but usually you have nozzles and manholes and trays and things of that kind in or on the surface of the vessel which is done usually by hand welding.

Q. Were there any automatic processes which were replaced by Unionmelt?

A. Oh, yes, there were several. In many places we re-

placed the automatic processes where coated electrode was employed on a long reel,—

The Court: What was that?

The Witness: Coated electrode. Atomic hydrogen, even a tornado arc; automatic bare electrode welding, and several places where flash welding and resistance welding had been formerly used, and in the rear fabrication, where spot welding had been utilized.

1117 By Mr. Fowler:

Q. Coming to the Lincoln Electric Company, the defendant in this suit, did you find that it was a factor in the electric welding industry?

A. Oh, yes.

Q. And what position did it hold in the welding industry?

A. They were always considered to be the largest in the electric welding field.

Q. And did you come into competition with the Lincoln Electric Company?

A. Yes, we did.

Q. Will you tell us about the installation at the Consolidated Steel Company which, I believe you said, was made in 1935. Did you come into contact with Lincoln Electric Company in that connection?

A. Yes, we did. I came in contact with some of the representatives of Lincoln Electric Company, because at the time they were carrying out experimental work for the Malheur project I mentioned a while ago. They were attempting to use the carbon arc welder on the inside of the seams of that project.

Q. Was someone out there as a representative of the Lincoln Electric Company?

1118 A. Yes. Mr. Maurice—

Q. Can you tell us what happened?

A. Well, he was there—

Q. What was his name?

A. Mr. Maurice Taylor. He was there to apply the carbon arc process, if possible, to the inside seam of the Malheur project, but his efforts were unsuccessful and as a result of his unsuccessful efforts they welded the inside and outside seam of the Malheur project with the Unionmelt process.

Q. Was he there when you were there, Mr. Cornwell?

A. He was.

Q. Did he see the Unionmelt process in operation?

A. He did.

1119 Q. Can you tell us when the Lincolnweld process and welding composition was introduced generally in industry?

A. It is pretty hard to say generally, but sometime in the latter part of 1943, I would say, or early part of 1943.

Q. Are you familiar, generally, with the reputation in industry of the Lincolnweld process?

A. Yes.

Q. Are you familiar with the reputation in industry of your own process?

A. Yes.

1121 Q. What difficulties have you had with the Lincoln Electric Company in connection with your licensing program in recent years?

A. Well, their activities made our licensing program more difficult.

1122 Q. Can you give us any further facts in that connection?

A. They advised prospective licensees, for example, to disregard our patents.

Q. And what about companies who were non-licensees, who did not hold licenses under the Unionmelt process?

A. The same in the case of those. They offered them patent protection against the patents which we hold.

Mr. Fowler: One last question, Mr. Cornwell:

By Mr. Fowler:

Q. What are the facts in connection with the Unionmelt process in connection with war production?

A. The Unionmelt process played a very important part in the welding of the various armaments for the army and navy, such as shipbuilding, the welding of armor plate and gun mounts, bombs of all types, and was utilized in practically every type of industry that was involved in producing equipment for the army and navy in which welding was utilized.

1123 By Mr. Fowler:

Q. Do the United States Army and the United States Navy, hold licenses under your process?

A. They do.

Mr. Fowler: You may cross-examine.

Cross-Examination by Mr. Van Duzer.

Q. Mr. Cornwell, referring to defendants' Exhibit No. 32, and the list of patents therein contained:

The first one listed there is Robinoff, is it not?

A. Yes.

Q. And that has been true in practically all of the forms of license which you have used, has it not?

A. They have been listed in numerical order.

Q. Well, no matter what the reason may have been, the Robinoff patent has been the first one listed on substantially all occasions; is that not the fact?

1124 A. Yes.

Q. And that is followed by Jones?

A. Yes.

Q. And then the others, the details of which you do not have in your mind?

A. I could not give you the details of the others at the moment, no, sir.

Q. But in any event, when the license agreement is presented to the customer, the first thing that is brought to his attention, if he looks at those patents, is Robinoff, is it not?

A. (No answer.)

Q. I mean, by the writing itself, now.

A. Oh, yes.

Q. And the Robinoff process is an arc process, is it not?

A. As far as I know, it is.

Q. Well, as a matter of fact, you do know that it is, do you not, Mr. Cornwell?

A. I would say so, yes, sir.

Q. Surely. And you testified so on the taking of your deposition, not only once, but several times, did you not?

A. Yes, sir.

1125 Q. Is your process an arc process?

A. I do not know.

Q. And you have testified to that on many occasions, have you not?

A. Yes, sir.

Q. You have no more knowledge on that subject at this moment, then you had in 1933; is that not the fact?

A. No more conclusive knowledge now.

Q. Right. Now, if a customer uses the Unionmelt process—or rather, when he uses it, he is practicing the teach-

ings of both Robinoff and of Jones, in those two patents, is he not?

A. I would say so.

1126 Q. That was purely a consent decree, was it not?

A. It was a consent decree.

1127 Q. It was a settlement, is that not true?

A. It was a consent decree, as far as I know.

Q. Do you recollect testifying on that subject when your deposition was taken in New York on August 22nd and 23rd, 1946?

A. I do.

Q. And you were sworn, you were under oath at that time?

A. Yes.

Q. And endeavoring then, as you are now, to tell the truth, is that correct?

A. That is correct.

Q. And did I not ask you these questions, and did you not answer as I shall read to you—and this relates to Western Pipe:

"Q. You did file such a suit?

"A. We did."

Do you remember that?

A. Yes.

Q. The next question:

"Q. It was settled, wasn't it?

"A. That is right."

Do you remember that?

A. Yes.

1128 Q. Then the next question:

"Q. And nothing was judicially determined in that case; it was pure settlement, was it not?

"A. Patents were not adjudicated, if that is what you mean."

Do you remember that?

A. I do.

Q. Now, when was it that you first learned of the Jones invention or claimed invention?

A. In January or February of 1933.

Q. Did you know about it before you received a letter from Mr. Hirst?—I will withdraw that question.

I hand you what has heretofore been marked Defendants' Exhibit 65.

(Whereupon said document was marked Defendants' Exhibit No. 92 for identification.)

By Mr. Van Duzer:

Q. (Continued.) And which is now marked as Defendants' Exhibit 92, and ask you what it is.

A. That is a letter dated February 21, 1934, to
1129 Mr. J. B. Hirst.

Q. And it was just about a year prior to that time that you first heard of the claimed invention, was it not?

A. That is correct.

Q. What was the means by which you heard of it?

A. I saw some samples of welds that had been sent in from San Francisco.

Q. Were they accompanied by a letter or a report from your San Francisco office?

A. I guess they were. I didn't see the report at the time, but—

Q. And that report is no longer in existence?

A. I don't know that it is.

Q. Well, you know you looked for it at a prior time?

A. We did.

Q. And could not find it?

A. Could not find it.

Q. That report came to Mr. Hirst, did it not?

A. It wasn't a report. As I understand, it was a letter from Mr. Hirst transmitting those weld samples.

Q. He was an officer of your West Coast subsidiary?

A. He was.

1130 Q. And immediately thereafter you went out to California, is that not so?

A. Not immediately, no. I went out there—

Q. Well, within thirty days or so?

A. No.

Q. Well, you were out there in April of 1933, were you not?

A. That is correct.

Q. Was it on that visit that you were accompanied by your patent lawyer, Mr. Greenwald?

A. I was not accompanied by him. I saw him in San Francisco.

Q. And while you were in San Francisco, you made a report to Mr. Critchett of your company, in the form of a letter?

A. That is correct.

Mr. Van Duzer: Will you mark this the next number, please.

(Whereupon said document was marked Defendants' Exhibit No. 93 for identification.)

By Mr. Van Duzer:

Q. I hand you now Defendants' Exhibit 93, and which was formerly marked as Defendants' Exhibit 54, and
1131 I will ask you if that is the report to which I have made reference?

A. It is.

Q. Who was Mr. Critchett?

A. He was vice-president of the Electro-Metallurgical Company.

Q. That is another subsidiary of Union Carbide?

A. That is right. He was also vice president of Union Carbide and Carbon Research Laboratory.

Q. By the way, you spoke of Lincoln as being a large company in the welding field. Union Carbide is also a very substantial, large firm, is that not true?

A. It is.

Q. And Linde, one of its subsidiaries, for many years was a leader in other types of welding than electric welding, is that not true?

A. That is right, and still is.

Q. And is it not also true that after the Jones patent was acquired you started to devote more and more of your time to Unionmelt?

A. That is correct.

Q. So that now that represents your key function, would you not say?

1132 A. I would say so, yes.

Q. From an operating standpoint, as distinguished from the legal standpoint, you are the officer of the company in charge of this case?

A. That is right.

Q. You have followed it from the outset?

A. I have.

Q. And have attended all hearings?

A. I have.

Q. Now, will you read to Judge Swygert the first paragraph on page 2 of Defendants' Exhibit 93?

A. (Reading):

"In welding a 1" plate they would use quarter-inch rod,

and in practically all of their welding on this thickness of metal would use 1200 amperes with a voltage of 30 to 33. At the time the work is placed in position and the electrode is set the backing up strip is clamped into position in order to prevent the metal from running through the bottom of the weld. The arc is then started with the standard voltage and amperage and within a few seconds the automatic travel is placed in operation. They have apparently
1133 experienced no difficulty in starting the weld and no special voltage or other precautions are necessary when starting. In making a weld on 1-inch metal they progress at the rate of 5 inches per minute. The quarter inch wire is fed at the rate of 30 inches per minute. They claim that it is impossible to permit a variation greater than 1/4 inch in the length of the arc, and for this reason a very sensitive automatic head is required. It is necessary to stop the weld about 3 inches from the end of the vee due to the reasons outlined above."

Q. When you wrote that to Mr. Critchett you had discussed the claimed invention with Jones and Kennedy, had you not?

A. I had.

Q. And with Hirst?

A. I had.

Q. And Hirst knew a great deal about it, did he not?

A. He had had several discussions with them. I presume he knew all they told him about it.

Q. In any event, whether you got your information
1134 from Hirst or from the inventors, or from what you saw, you told Mr. Critchett twice in that paragraph that there was an arc present, did you not?

A. That is what the paragraph—

Mr. Fowler: The paragraph speaks for itself, your Honor. We object to that question.

By Mr. Van Duzer:

Q. Did you have any information from any source other than Hirst or the two inventors?

A. None whatever.

Q. The description which you gave to Mr. Critchett, assuming it to be accurate—that is, assuming that there was an arc present—sounds a great deal like Robinoff, does it not?

A. Not a bit.

Q. In any event there is nothing in that report that
1135 indicates any doubt in your mind of the existence of an arc?

A. I was not expressing my opinion at that time.

Mr. Van Duzer: May we have this marked as Defendants' Exhibit 94 for identification.

(Whereupon said document was marked Defendants' Exhibit No. 94 for identification.)

Mr. Fowler: What paper are you having marked please?

Mr. Van Duzer: Defendants' former Exhibit 7 is now being marked Defendants' Exhibit No. 94.

By Mr. Van Duzer:

Q. Did you make a further report to Mr. Warzeski on May 19, 1933?

A. I did.

1136 Q. Is that which I show you, which has been marked as Defendants' Exhibit No. 94, a copy, a carbon copy of that report?

A. I believe it is.

Q. Who was Mr. Warzeski?

A. Mr. Warzeski was at that time vice president of Linde Air Products Company.

Q. Was he at that time superior to you, in the company?

A. He was.

1137 Q. You stated to Mr. Warzeski, did you not:

"The arc is then started with standard voltage and amperage, and within a few seconds the automatic travel is placed in operation?"

A. That is what it says there.

Q. And down toward the bottom of the page, do you not also say:

"The welding operation is conducted with a submerged arc, or in other words, the arc is submerged in the deep flux"?

A. Where are you reading?

Q. Right here (indicating).

A. That is correct; that is what it says here, yes, sir.

Q. When did you first begin to have any doubts as to the existence of an arc, Mr. Cornwell?

A. At the time of my first discussion with the in-
1138 ventors.

Q. But those doubts you did not transmit either to Mr. Critchett or Mr. Warzeski?

A. I did verbally, yes, sir.

Q. I am speaking now of the two exhibits, or of the two reports.

A. I don't recall whether it is mentioned in those letters or not. I have not read them for some time.

Q. Between that time and the time that the second application for the patent was filed, what tests that you know of had been made, indicating any doubt as to the existence of the arc?

A. I don't know of any.

Q. And even to this day, you do not know whether there is or is not an arc, do you?

A. I could not prove it either way.

Q. Now, did Mr. Hirst make a report to you under date of May 5, 1933,—to you and Mr. Suydam?

A. Yes.

Mr. Van Duzer: May we have this marked, please, 1139 as Defendant's Exhibit No. 95 for identification.

(Whereupon the said document was marked Defendants' Exhibit 95 for identification.)

By Mr. Van Duzer:

Q. I will ask you to state whether or not Defendants' Exhibit No. 95 for identification, formerly Defendants' Exhibit No. 25, is the report of which you speak?

A. It is a letter from Hirst to Suydam, with a copy to me.

Q. Now, I direct your attention to the last paragraph on the first page of that letter, in which Mr. Hirst says to Mr. Suydam—

1141 "With full knowledge of the patent, I personally am more convinced than ever that we should acquire the process, and believe that we will have no difficulty in getting our money out of it quickly, even though we should have to pay the full price asked by the inventors.

"I feel certain, however, that it can be had for something less than this price."

What was the full price that was asked by the inventors?

A. I don't know what he refers to.

Q. Do you know what he had in mind when he spoke about getting the money out of the patent quickly?

A. The same as any other investment.

1142 Q. When did you take out a license under the Robinoff patent?

A. I believe it was some time in 1938.

Q. And what were the circumstances leading to that?

A. We were served notice of infringement by the Na-

tional Tube Company, and we decided to take the license of the patent because we had given all of the licensees patent protection.

Q. And you did that, I take it, after full consideration and after advice—I am not asking you what it was—of counsel?

A. Certainly.

Mr. Van Duzer: Will you mark that as Defendant's Exhibit 96.

(Whereupon the said document was marked Defendants' Exhibit 96 for identification.)

1143 Q. Handing you now Exhibit 96, formerly Exhibit 81, I will ask you if that is the communication from National Tube claiming that the Robinoff patent was being infringed by you?

Mr. Van Duzer: Will you please mark these documents as Defendants' Exhibits 97, 97-A, B, and C.

(Whereupon the said documents were marked respectively Defendants' Exhibits 97, 97-A, 97-B and 97-C, for identification.)

Q. I now hand you Defendants' Exhibits 97, 97-A, 97-B and 97-C, formerly Defendants' Exhibits 28, 28-A, B

1144 and C, and ask you whether, taken together, they constitute the license from National Tube as modified from time to time, of the Robinoff patent.

A. They do.

Q. And from that day to this, you have been paying Royalties to National Tube?

A. That is right.

Q. What royalty are you now collecting under your own licenses?

A. You mean per pound?

Q. Yes.

A. Five cents per pound of metal deposited.

Q. What was it in 1942, let us say?

A. What time in 1942?

Q. January 1st.

A. At that time it was 15 cents per pound on the first 50,000 pounds per year, and 10 cents per pound for all over 50,000 pounds.

Mr. Van Duzer: Can we have these marked? These were 83-A through 83-Y.

(Whereupon the said documents were marked respectively Defendants' Exhibits 98-A through 98-Y for identification.)

1145 By Mr. Van Duzer:

Q. I hand you Defendants' Exhibits 98-A through 98-Y, inclusive, and ask you what they are?

A. A group of general instructions, letters, regarding the handling of Unionmelt welding process.

Q. They are letters to salesmen, in the main, are they not, or sales managers?

A. That is correct.

Q. And they instruct the sales force as to how to conduct itself in selling licensees under the Jones patent, many of them?

A. That is right.

1146 Q. I direct your attention to Defendant's Exhibit 98-C, the second page at the bottom.

A. Which one?

Q. Defendants' Exhibit 98-C, the third one, the instructions under date of March 8th, 1943.

A. Yes.

Q. That is page 2, the last three lines on the page.

A. Yes.

1147 Q. (Reading.) "When purchase contract forms for Unionmelt welding rod are to be submitted to a prospective licensee they will be prepared and sent to the district office with the license agreement forms. The space for entering the beginning date of the contract should 1148 be left blank to be filled in at the time the contract is negotiated."

By Mr. Van Duzer:

Q. Do you see that?

A. I do.

Q. And immediately following that:

"The rod purchase contract should not be presented or seriously discussed until after the license agreement forms have been presented to the prospective license, and when possible the negotiation completed."

Do you see that?

A. I see that.

Q. Do you remember that in New York in October when your deposition was completed, I interrogated you on the subject of the purpose of that instruction? Page 284, Mr. Fowler?

Do you recollect you were interrogated on that subject?

A. I believe so.

Q. Do you remember these questions and answers:

"Q. Well, your current instructions to your sales-
1149 men are to avoid having the contract and the license executed the same day, aren't they?

"A. I think they have been under instructions right along."

Do you remember that?

A. I do.

Q. And this question:

"Q. What is the purpose of that?"

Then that was repeated, and you said:

"I could not tell you."

Do you recollect that?

A. I do.

Q. Then do you recollect that after asking you who Mr. Outcalt was, the sales manager, I said to you:

"Don't you know perfectly well what the reason for that instruction is?"

And you said:

"Yes, I presume so.

"Q. All right. Now tell us.

"A. Just so that no one could gain an inference that there was any connection between the two.

1150 "Q. In other words, it is to avoid the appearance of a tie-in agreement, isn't it?

"A. That is correct."

Do you recollect that?

A. I do.

Mr. Van Duzer: Now, may we have these marked as the next two exhibits, please. They are former Defendants' Exhibits 26 and 26-A and 27.

(Whereupon said documents were marked Defendants' Exhibits Nos. 99 and 100 for identification.)

Mr. Fowler: What is being marked, Mr. Van Duzer?

Mr. Van Duzer: Defendants' former Exhibits 26 and 26-A are marked as Defendants' Exhibit 99, and Defendants' former Exhibit 27 is marked as 100. I am very nearly through, your Honor.

The Court: You may proceed until you are through.

By Mr. Van Duzer:

Q. Handing you now Defendants' Exhibits 99 and 99-A being a document in two pages, formerly Defendants' Exhibits 26 and 26-A, I will ask you what it is?

1151 A. It appears to be a copy of an agreement signed by J. B. Hirst of the Linde Air Products Company and Jones, Kennedy and Rotermund.

1152 Q. It had to do with disclosing the patent application to you, and what would occur in case you did not buy; that was the general subject-matter, was it not?

A. Yes.

Q. Now, I direct your attention, Mr. Cornwell, to the first recital in the second paragraph, reading as follows: "Whereas, the inventors claim to have discovered a method of electric arc welding, including a flux therefor." and I ask you to state who drew this contract?

A. I presume it was done by Mr. Oddie, but I do not know.

Q. He is a California lawyer, is he not?

A. Yes.

Q. And presumably he got his instructions from Mr. Hirst?

A. I presume he did.

Q. And he presumably was told that there was an arc there?

A. I presume he got that from the instruction of the patent. The same wording that is there.

Q. Now, what is Defendants' Exhibit 100, 1153 formerly Defendants' Exhibit 27?

A. This is a letter from L. T. Jones, addressed to J. B. Hirst, transmitting a copy of the patent office action dated May 27, 1933, with U. S. Application 567,836.

Q. Does that refer to any other patents?

A. Oh, yes.

Q. It refers to the Robinoff patent, does it not?

A. That is the last one that is referred to.

Q. But the Robinoff is the one under which you have taken a license from the National Tube Company; is that right?

A. The same patent.

Q. And the first one that is listed on your license agreements?

A. Yes.

1154 Q. Well, it is a fact that the second application was filed by the lawyers of Union Carbide; is that not true?

A. That is correct.

Q. And it is also a fact, is it not, that in the second

application, the arc is no longer referred to, and the term "conductive melt" is referred to?

A. That is correct.

Q. Yes. And those lawyers were Greenwald & Scheffler; is that correct?

A. Yes, sir.

Q. Greenwald had been in California with you, had he not?

A. Yes, sir.

Q. Now, when we were talking about the Western Pipe litigation, first Mr. Cahill, and later Mr. Fowler, talked about consent decrees, and the position of the United States government.

So far as you know, is there any case at the present time between the United States government and the Lincoln Electric Company involving any of these patents, or any of its sales policies?

A. I have no information of any.

1155 Q. Is there a suit pending by the United States government, the Anti-Trust Division, against the Linde Air Products Company in Chicago?

A. There is.

Q. I hand you now, Mr. Cornwell, what has already been marked as Plaintiff's Exhibit No. 158, purporting to be a letter from you to Mr. Hirst, transmitting the application, oath and power of attorney upon the second application for the patent.

Do you recollect having sent that letter?

A. Yes, sir.

Q. What did you mean when you said:

1156 "I have gone over all of the contained subject-matter in the proposed application with Mr. Becket, and he is entirely in accord with the manner in which the specification and claims have been drawn.

"It is quite possible that certain features of the specification may seem objectionable on the first reading, but these matters have already been carefully considered, and the general feeling is that is should be filed in its present form."

1157 I will withdraw my former question, and I will ask another question.

By Mr. Van Duzer:

Q. I will ask you, Mr. Cornwell, to whom did you think that might prove objectionable?

1158. A. Mr. Hirst.

By Mr. Van Duzer:

Q. Are you certain that you did not mean that the inventors, who had to sign these documents might find the the shift of theory objectionable?

A. We did not shift any theory.

Q. You say that you thought—or that you meant Mr. Hirst was the one who might object?

A. That is the only one I could think of, yes, sir, because the inventors expressed to me, and to Greenwald—

1159 Mr. Van Duzer: You have answered the question.

By Mr. Van Duzer:

Q. Now when you said:

"—and the general feeling is that it should be filed in its present form."

Whose general feeling was that?

A. Well, I presume that was mine.

Q. Well, you say that "it is the general feeling."

A. Yes.

Q. You had not consulted the inventors at that time, as yet, had you?

A. I consulted them, yes, sir, when I was talking to them, previous to the rewriting of the specification.

Mr. Van Duzer: Pardon me; may I hear that last answer again please, Mr. Reporter.

(Answer read.)

By Mr. Van Duzer:

Q. And you say that when you told Mr. Hirst:

"* * * and the general feeling is that it should be filed in its present form" that embraced the feeling of the inventors, in your mind?

1160 A. It was up to them, to judge. They could change it if they wished to do so.

Q. Now, do I also understand you to say that the theory had not been changed?

A. Changed from what?

Q. Changed from an arc process to what you now claim you have, whatever it may be?

A. As expressed in the two applications, it is different.

Q. Now, I direct your attention to this language:

"You will note that the welding process has been defined as a process entirely different from the arc welding pro

cess, and consequently the use of the arc has been excluded throughout the application.

"This is also true in the case of the word 'flux' which has been replaced by the term 'conductive melt.' "

Do you now say to Judge Swygert that that does not represent a change of theory?

A. I don't know that it represents a change in theory. It represents the best knowledge of the inventors in expressing what they thought was taking place.

Q. My question was, do you say that there was no
1161 change in theory as between the first and second applications; and I would like to have you answer that directly.

A. Why, I would say the theory as expressed in the two applications is different.

1162 Mr. Van Duzer: At this time, your Honor, we will now offer in evidence as part of the respective cross examinations of the witnesses who were on the stand when identified, all of the exhibits identified by the Defendants.

1165 The Court: Very well, the exhibits will be admitted.

(Whereupon DEFENDANTS' EXHIBITS NOS. 88 to 100, both inclusive, were admitted in evidence.)

Mr. Fowler: Mr. Cornwell.

ROSS EUGENE CORNWELL, called as a witness on behalf of the Plaintiffs, having been previously duly sworn, resumed the stand and testified further as follows:

Redirect Examination by Mr. Fowler.

Q. Mr. Cornwell, on your cross examination your attention was directed to a letter which you wrote to Mr. Hirst, which is Plaintiff's Exhibit No. 158, and you were asked concerning something in there as to the amendment to the Patent Application being objectionable.

You were asked specifically whether you meant that it might be objectionable to the inventors, and then when
1166 you attempted to explain in your answer, your answer was cut off, as indicated at page 1158 of the stenographic transcript.

Would you please state your reasons, or your explanation in that connection.

A. As I started to say, at that time we had tried to incorporate in the revised specification the thoughts of the inventors, and I could not see any reason why there would be anything in there objectionable to them.

1167 Q. Now, your attention was also directed to the fact that you took out a license—that the Linde Air Products took out a license under the Robinoff patent; and I ask you to state your reasons why you took out the license.

A. We were served with notice of infringement by the National Tube Company, in the latter part of 1936, and at that time we had approximately thirty licenses—excuse me. We received notice of infringement from the National Tube Company in the latter part of 1936, advising us we were infringing the patent.

We had a number of licensees to which we had guaranteed patent protection. The number had increased to about thirty, in 1938, and at that time we thought it would be wise, for business reasons, to take out a license under the Robinoff patent because we had guaranteed them patent protection.

Q. On what date did you take out that license?

A. I think it was around April 1st, 1938.

Q. In your negotiations with your licensees, did you discuss any patent or patents?

A. We did.

1168 Q. What patent?

A. The patent discussed in practically every case was the Jones patent.

Q. Did any of the licensees ever ask you about any other patents, in those negotiations?

A. Not specifically, no.

Q. Now, prior to this date, April of 1938, when you obtained a license for the use of the Robinoff process, you had already negotiated a number of licenses?

A. We had.

Q. Could you tell us some of those licenses?

A. Consolidated Steel Company; American Rolling Mills; Sun Shipbuilding & Drydock; Griscom-Russell; Electro-Motive Corporation; Taylor Pipe & Forge. I think those are the important ones.

Q. On what date does the Robinoff patent expire?

A. It expires in October, 1947.

Q. Well, I believe the answers of the defendants in this case show that the patent was issued on November 18, 1930 and it would therefore expire on November 18, 1947.

Do you accept the correction?

A. I do.

Q. Have you ever negotiated a license that ex-
1169 pired on that date?

A. We have not.

Q. And your current form of license agreement expires on what date?

A. June 9, 1953, which is the expiration date of the Jones patent.

Mr. Fowler: No further questions.

Mr. Stewart: If the Court please, may I cross-examine at this time, in Mr. Van Duzer's absence?

Mr. Fowler: No objection.

The Court: Very well, proceed.

Recross Examination by Mr. Stewart.

Q. Mr. Cornwell, you say that the only reason that you took a license under the Robinoff patent from the National Tube Company was for business reasons and because you had about thirty licensees to whom you had guaranteed patent protection; is that a fair statement of your position?

A. That is correct.

Q. Mr. Cornwell, National Tube Company, I believe you said, did accuse Linde Products Air Company of infringing the Robinoff patent?

1170 A. I believe that is correct.

Q. That was by letter from National Tube dated August 1, 1936?

A. I believe that is the correct date.

Q. You recall when your deposition was taken, Mr. Cornwell, you were asked a series of questions directed toward distinguishing the Unionmelt process from the Robinoff process; do you recall that series of questions?

That begins on page 170 of Mr. Cornwell's deposition.

A. I do.

Q. Do you recall that?

A. I do.

Q. I will read to you from your deposition and ask you whether those questions were asked you and you gave the answers as I read them:

"Q. Now, I want to direct your attention to the Robinoff patent for a moment, number 1,782,316, patented Novem-

bet 18, 1930. The process there patented was a con-
1171 tinuous welding process, was it not?"

There was an objection, or a statement by Mr. Wolfe. You said:

"Patented. That is what was covered by the claims in the patent."

"Mr. Van Duzer: Yes, covered by the claims and described in the patent.

"Mr. Wolfe: As far as what the claims cover, that is a matter of legal interpretation. I do not think it is proper to inquire about it of this witness.

"Mr. Van Duzer: I think it is. This is preliminary.

"Mr. Wolfe: You can answer as to what is described, if you understand it."

Then Mr. Van Duzer put this question:

"Q. In the very first paragraph of the Patent it states, 'This invention relates to methods' "—

and this is the Robinoff patent—

" 'of welding and while not limited thereto relates particularly to a method of forming continuous seam welding, such
as when forming large cylindrical articles like pipe,
1172 tanks, etc.' In that respect it parallels yours, which was also a continuous method, was it not?

"A. Yes, that is right.

"Q. And you find in line 19 another even clearer reference to the continuous weld rod; that is line 19 on the left column of page 1?

"A. That is right.

"Q. And then it goes on to state, 'Heretofore weld rods have generally been coated with a flux material and such rods cannot be reeled since reeling will break off the flux;—' That fact is something that you pointed out in your own affidavit, isn't it, that the coating on the weld rod prevents reeling?

"A. That prevents reeling them in small coils.

"Q. And you mentioned that in your affidavit?

"A. Correct.

"Q. So that Robinoff did have in mind a continuous process, and he did have in mind the difficulty of a
1173 continuous process with the coated rod?

"A. Apparently he did.

"Q. Now then he says, 'In carrying out our method the edges of the plate or plates to be welded are first champfered and then brought into an abutting position to form

a U or V-shaped groove along the line of weld.' In some fashion that is done''—I believe that is ''same fashion'' —''that is done in the Unionmelt process, isn't it?

"A. That is right. They may be beveled but they can or they cannot be.

"Q. And then beginning in line 45 in the same column, 'After the groove has been filled with flux the welding head of the welding machine, having a reel of welding rod or electrode wire thereon, is started in operation to feed the electrode down into welding position with respect to the flux filled groove—.' That, in general, is what you do, isn't it, as far as it goes?

"A. No, we do more than that. We heap it up over the groove. That says 'flux filled groove' only.

1174 "Q. You pile it higher?

"A. That is right.

"Q. But with that exception that broadly describes what you do?

"A. Well, I don't know what he refers to when he says 'with flux'; I haven't any idea because he does not say in his patent.

"Q. Well, but in your case you not only fill but overfill the groove with your flux, and then the continuous wire proceeds from a reel down through the flux into the groove where there is a groove and there the welding takes place?

"A. That is right.

"Q. All right. And then he proceeds to speak of feeding the electrode longitudinally of the groove. That also is done in your process, either by moving it or moving the work piece?

"A. That is right.

"Q. 'After the electrode,—' says the patent, 'is brought into proper position an arc will be struck so as to melt the flux in the groove and also to melt the metal of the electrode so as to furnish a deposit of metal in the groove.' Now

1175 there, I understand that in your case no arc is struck, or if it is, it is a different kind of arc.

"A. That is right."

Do you recall saying that, Mr. Cornwell?

A. Right, I do.

Q. Continuing:

"Q. But otherwise the same thing happens, that is to say the flux is melted and a deposit of metal is made in the groove which accomplishes the weld?

"A. I can't tell whether the same thing happens or not, because I don't know what materials he is using here.

"Q. All right, but in broad terms, irrespective now of the character of the arc, his flux was melted and the electrode is melted; that is true in each instance, isn't it?

"A. That is right.

"Q. And the result is metal deposited in and along the groove or adjacent to the plates to be welded?

1176 "A. That is right.

"Q. Now then he says, 'as the welding operation progresses the welding rod will be continually melted—.' True in your case?"

1183 "A. That is right.

"Q. 'And the metal, being of greater specific gravity'—

"This is still in quotation marks

"'—than the molten flux, will cause the flux to rise in the groove as the metal is deposited.'

"Now, is that true in your case?

"A. That is true.

"Q. 'The movement of the welding rod is so timed that the proper amount of molten metal will be deposited to fill the groove the desired amount, as the rod passes along the groove.'

"That is the same thing that you accomplish yourself, is it not, in your process?

"A. Correct.

"Q. And you do that by timing the welding rod?

1184 "A. That is right.

"Q. 'In carrying out this method, the molten metal deposited from the electrode is at all times covered by a layer of flux?

"Right, in your case?

"A. Right.

"Q. 'In the form of a slag.'

"And I suspect you will say that slag is not a very good term; is that right?

"A. Probably.

"Q. But it is a common term, is it not?

"A. It is a common term.

"Q. Quoting again from the Patent

"'And therefore the deposited metal from the electrode will remain molten, a sufficient time to permit any entraining gases to escape.'

"Is that true in your case?

"A. That is right.

"Q. And the deposited metal will not become oxidized, since the flux or slag protects the molten metal from the atmosphere.'

"That is also true in your case, is it not?

"A. That is true, right.

1185 "Q. Coming to the claims of the patent, I will read you Claims 1 and 8.

"'No. 1. In a method of seam welding, the steps'"—

1191 Mr. Stewart: The last that I read, I believe, was where Mr. Wolfe raised an objection, and Mr. Van

1192 Duzer made this statement:

"I am not going to ask him what it covers. I am going to ask him, however, in a layman's sense, for differences.

"Q. Claim 1, 'In a method of seam welding the steps of first-forming a groove along the seam to be welded—'

"Stopping the quotation there: you form a groove along the seam to be welded, don't you?

"A. That is right.

"Q. '—filling said groove with flux—'

"Stopping there: you do that, and then put it on a little higher?

"A. That is right.

"Q. '—causing said flux to become molten—'

"Your process does that?

"A. Causing part of the flux to become molten—'

"Q. Well, tell us more about that.

"A. Well, all the granular material we use is not fused in the welding operation.

1193 "Q. Was it all molten in the case of the Robinoff process?

"A. I don't know. That is what it says.

"Q. '—and depositing the welding metal through said molten flux so as to cause said flux to rise over and form a layer on said metal.'

"That happens whenever your process is used, doesn't it?

"A. That is right.

"Q. And in No. 8 I now read, 'In a method of seam welding the steps of first forming a groove along the seam to be welded, then depositing a body of flux in said groove, and then moving a metal electrode along said groove and drawing an arc causing said flux to melt and melting said

electrode so as to deposit the molten metal from said electrode through said melted flux.'

"The users of Unionmelt accomplish all of those things except, as I understand it, you are not prepared to admit that an arc is drawn, or if so, that it is an arc of the usual type?

1194 "A. That is right.

"Q. If it turns out that there is an arc and of the usual type, what is the difference between the Robinoff process and yours?

"A. Tremendous difference.

"Q. I am not speaking now of the composition of the flux, the process itself. If there is an arc what is the difference?

"A. Tremendous difference.

"Q. What is it?

"A. Because the composition and method of preparation of the Unionmelt used permits an entirely different welding operation to take place, which could not be done with the Robinoff process.

1197 Mr. Stewart: Skipping to the next question:

"Q. All that is left, as a matter of fact, is the 1198 composition of your flux and the dispute about whether there is an arc, isn't there?

"A. I don't think so.

"Q. What else is there, what are the other differences?

"A. The other differences are that you can weld with much heavier currents, much higher speeds and better quality of welding than can ever be done with the Robinoff process.

"Q. What accomplishes that other than, as you claim, the absence of an arc or the composition of your flux or both in combination?

The Court: Read that over again.

Mr. Stewart: (Reading):

"Q. What accomplishes that other than, as you claim, the absence of an arc or the composition of your flux or both in combination?

"A. The absence or presence of an arc has nothing to do with it at all. It is the welding operation that 1199 takes place beneath this blanket of material which is possible with the prefused composition which is utilized in the Unionmelt process."

Mr. Stewart: And I believe, following the continuity, I can skip down to the middle of the page.

1200 Mr. Stewart: (Reading):

"Q. Let me finish my question—the processes are the same, aren't they?

"A. I can't leave out the composition of the material utilized.

"Q. Well, you can't leave out an assumption because you don't like to answer the question?

"A. I don't like to assume something that is untrue.

"Q. You don't know that it is untrue, you said.

"A. What is untrue?

"Q. That there is an arc in your process.

"A. I am not talking about the question of an arc. I am talking about the composition of the material utilized to conduct the current from the rod to the plate. The material that Robinoff uses is something entirely different.

"Q. All right, that is one difference.

"A. A great difference.

"Q. And which you think helps to bring about a much better result; that is correct, isn't it?

1201 "A. There is no question about that.

"Q. And the dispute, if there be one, about the presence of an arc is No. 2, isn't it; that is the second difference?

"A. No.

"Q. No? Why not? What do you mean by that?

"A. There has never been any dispute about whether an arc exists in the Robinoff process.

"Q. In yours?

"A. It is immaterial.

"Q. In what other respect does Robinoff fail to describe your process?

"A. You mean the specification?

"Q. I mean just what I said. You have pointed out the difference in the flux composition, and you have pointed out that Robinoff has an arc which you don't admit. Now I ask you if in any other respect Robinoff fails to describe your process?

"A. I can't admit that at all.

"Q. Is there any other respect than the two mentioned in which Robinoff does not describe the process iden-

1202 tical in substance with yours?

"A. The fact that the welding operation is carried out beneath this quiet layer of material, which does not exist in the Robinoff process.

"Q. That is a matter of difference in the composition of the flux, isn't it?

"A. Everything must hinge on one or two facts. When you assume that they are the same in both cases it has no merit."

1204 By Mr. Stewart:

Q. You recall those questions which were asked and those answers you gave at that time, do you not, Mr. Cornwell?

A. I do.

Q. Another question, Mr. Cornwell: I think what has been marked and identified as Plaintiff's Exhibit 158 is the Unionmelt Welding Operator's Manual, which has already been introduced in evidence in connection with your testimony.

You are thoroughly familiar with that, are you not?

1205 A. Oh, yes.

Q. That is put out as an instructional guide to operators of your process, is it not?

A. That is right.

Q. And on page 17, under the heading "Use of Unionmelt", the following appears, does it not—and I am reading:

"The depth of the layer of Unionmelt applied should be no greater than is necessary to assure reasonably quiet welding action and to eliminate any tendency toward visible arcing."

That is an instruction in your manual, is it not?

A. Yes, that appears there.

Q. And on page 21, the following appears, does it not:

"The layer of Unionmelt used should be just sufficiently deep to prevent open arc flashing. If a deeper layer is used it may upset the welding action, and cause uneven welds. The best conditions are indicated when an almost continuous flame burns around the rod and there is continu-

1206 ous agitation of the granulated material adjacent to the rod."

That also appears as an instruction to operators of the Unionmelt process, does it not, in Plaintiff's Exhibit 158?

A. That is right.

Mr. Stewart: That is all, your Honor.

If the Court please, I would just like to make one state-

ment in the record. I used the words "Plaintiff's Exhibit 158." I was in error in regard to that Unionmelt manual. That was Exhibit 211, Plaintiff's Exhibit 211.

Redirect Examination by Mr. Fowler.

Q. Just one question, Mr. Cornwell: You have stated that a customer who uses the Unionmelt process is practicing the teachings both of Robinoff and of Jones-Kennedy. Will you tell us what part of the teachings of Robinoff he is practicing?

A. Placing flux on the work to be welded.

1207 Mr. Fowler: That is all.

Mr. Stewart: No questions.

(Witness excused.)

Mr. Cahill: If your Honor please, Plaintiff rests.

(And here the Plaintiff rested.)

Defense.

And thereupon the Defendants, to support and maintain the issues on their behalf, introduced the following evidence:

Mr. Oberlin: The defendants call Mr. Lincoln as the first witness.

JAMES FINNEY LINCOLN, called as a witness on behalf of the defendants, having been duly sworn, testified as follows:

Direct Examination by Mr. Oberlin.

Q. Your full name is James Finney Lincoln?

A. James Finney Lincoln.

Q. And you are a resident of—

A. I live in Cleveland.

1208 Q. You are a resident of Shaker Heights, a suburb of Cleveland?

A. Yes.

Q. What is your occupation or business, Mr. Lincoln?

A. I am president of the Lincoln Electric Company.

Q. One of the defendants in this action?

A. Yes.

Q. How long have you been president of the company?
A. Since 1928.
Q. Were you connected with the company prior to that?
A. I first came with the company in 1907 when I finished college.
Q. Have you been connected with it continuously in the interval?
A. Yes.
Q. What was your first position?
A. Salesman.
Q. State the successive positions you have held.
A. After that I became executive head of the company as vice-president, in 1914, and have been executive head of the company since.
Q. Who was your predecessor as president?
A. My brother, J. C. Lincoln, and he was the founder of the company.
1209 Q. Is he still connected officially with the company?
A. He is chairman of the board.
Q. Is he particularly active at the present time?
A. He has not been active since 1914.
Q. Where does he reside at the present time?
A. He resides, most of the time, in Phoenix, Arizona.
Q. You say your brother was the founder of the company.
A. Yes.
Q. When was it founded?
A. He founded the company in 1895.
Q. Was it incorporated at that time, or subsequently?
A. Incorporated, I think, in 1906, or 1907.
Q. You spoke of coming with the company in 1907, I believe, fresh from college.
A. Yes.
Q. What had been your educational training?
A. I took a course in electrical engineering at Ohio State University.
Q. Have you a degree?
A. Electrical engineer.
Q. What was the business of the company when you came with it out of college in 1907?
A. The manufacture of direct and alternating cur-
1210 rent motors and some specialties.
Q. What is the nature of its business at present?

A. We manufacture arc-welding equipment and electrode, with some supplies.

Q. Were you making any arc-welding equipment in 1907?

A. The first arc-welding machine we made was in 1907, after I came with the company.

Q. You have then had the opportunity, during the period of your connection with the company, of seeing the entire development of its business in that field, is that correct?

A. Yes.

Q. And you have had some part in that development, I take it?

A. A good deal.

Q. Was there much arc-welding being done in 1907?

A. Compared to what there is now, very little.

Q. What is the size of your company? How many employees does it have at its plant?

A. At the present time in the plant there are between eight and nine hundred employees.

Q. That plant is located in Cleveland?

A. Cleveland.

Q. I shall presently ask you some questions about 1211 electric arc-welding, but before that may I ask you as to your general acquaintance with the welding industry and procedures employed in welding, apart from electric arc-welding.

A. What is the question?

Q. Are you acquainted with welding procedures generally?

A. Very definitely.

Q. As you indicated, especially with electric arc-welding?

A. Yes.

Q. Is there another variety or kind of welding in which electricity is used, other than arc-welding?

A. Well, what is called the resistance process is used very largely.

Q. Has your company ever exploited that method of electric welding by equipment or otherwise?

A. Not at all.

Q. Before the use of electricity in welding, how was welding accomplished?

A. Welding is one of the oldest arts known to man. It

far antedates the Christian Era. The welding of steel and iron was done for generations before that.

1212 Perhaps you remember the Damascus blade which was made up of strips of steel which were welded together, and that antedated the beginning of the Christian Era.

The welding of steel together has been going on continuously since that time, and was in 1907, for instance, being done by tens of thousands of blacksmiths all over the world.

Q. You spoke of welding strips of steel together and of blacksmith welding.

A. Yes.

Q. What is the term applied, the general descriptive term, to that kind of welding?

A. Well, I think "blacksmith weld" would be as good as any. In that case the steel is melted up to the plastic state, which is below the melting temperature, and the surfaces to be welded are cleaned with some borax or some other flux. Then they are put together and hammered or pressed and a weld results from that.

Q. The term you apply to that kind of welding is forge welding, is that correct?

A. Forge welding, or very frequently called blacksmith welding.

1213 Whether accomplished in the case of the union of small articles, or in the case of very large articles?

A. Yes.

Q. This flux that you spoke of—is that placed over the surfaces that are to be brought together and welded?

A. Yes.

Q. Have there been various fluxes thus used, to your knowledge?

A. Yes. There have been a number of them.

Q. You mentioned borax as one?

A. Yes.

Q. There have been others?

A. There have been a number of others.

Q. Is there any other method of welding than this forge welding that was in use or known prior to the use of electric-welding?

A. There had been a certain amount of welding done by melting metal and pouring it between two pieces to be

welded, which might be called fusion welding. The thermit process is one of those.

Q. I think the thermit process was mentioned either in opening statements or in the course of previously given testimony. What is the nature of that process?

1214 A. In that case powdered iron and—wait. Powdered iron oxide and powdered aluminum, metallic aluminum, are mixed together and ignited. It forms a very high temperature, a very great amount of heat, and results in the melting of the iron and the reducing of it to metallic iron.

Q. That is used now in the actual welding operation?

A. It is then poured into a mold which encloses the two ends to be welded and forms a casting about the two ends.

Q. Did you speak of that, or did I understand you to say that that exemplifies one form of fusion welding?

A. Yes.

Q. That is a proper term to apply?

A. Yes.

Q. What is one familiar use of this thermit welding process?

A. It is used very frequently in the welding together of rails in street railways where the rails are buried beneath the ground. It is used also in the welding of large castings; for one place, in the shipbuilding industry where the stern post is welded.

1215 It is only done commercially where large sections are to be welded and where it is a difficult thing, or a more expensive thing to do it by other means.

Q. Now, coming to electric welding with the use of the electric current as a welding medium or agency, and ignoring the resistance electric welding, what of these general types of welding does electric arc-welding exemplify? Is it more analogous to forge welding or fusion welding?

A. It is a means for fusion welding. It was the great step that was taken over forge welding and fusion welding, the great step that has been taken in that process.

The beauty about it is that it releases the heat exactly where you want it. In the first place, it releases the heat on the parts to be welded so that you will melt those parts. It releases the heat also, at the same time, on the electrode itself so that the molten metal for joining the two pieces together is automatically released for that.

It is because of the discovery of the use of the arc, which

was done in the late 80's, that any step was taken forward compared to the previous methods which had been used.

1216 Q. What about the intensity of the heat that you have to apply where heat is provided by means of an electric arc compared with these other means?

A. The temperature of the arc is the molten temperature of the electrode—I mean, the boiling temperature of the electrode.

Q. Is that hotter than you could get, for instance, with these other methods like forge welding and fusion welding?

A. Tremendously higher.

Q. Unless there has been achieved in recent wartime development of atomic fission a higher temperature, has there been any higher temperature available than that developed by the electric arc, heretofore?

A. Practically speaking, no. Theoretically, you could.

Q. You spoke of electric arc-welding as dating back to the early 90's or even 80's. Who first thus utilized or described the utilization of the electric arc for welding purposes?

A. The first description was by a Russian named Bernardos which, I think—I may be wrong on the exact date—was in 1888.

1217 Then another Russian named Slavinoff came along with the idea of welding with a metallic electrode. Bernardos' was the carbon electrode, that he described and patented, and Slavinoff described and patented the metallic electrode process.

Q. Are both these methods, that is, the carbon arc process and metallic electrode process of electric arc-welding still utilized in the industry?

A. Yes.

Q. Does your company provide equipment and material for practicing electric arc-welding using either or both of those?

A. Both.

Q. I assume that some improvements have been made in the interval since the original inventors' disclosure of these processes of electric arc-welding?

A. There have been great improvements made both in the machinery and the process, as would be expected on any process of that kind which is going to have wide use.

Q. We will make some inquiry along those lines.

First, let me ask you whether bare metal electrode or weld rod is still commercially used?

A. Yes, in rather large quantities.

1218 Q. So far as the weld rod itself is concerned, it is substantially that which the original inventor back in 1880 or 1890 disclosed?

A. Exactly the same.

Q. Your company sells bare metal electrode?

A. Yes.

Q. What is the range of current sales?

A. We are selling in excess of one hundred thousand pounds a month of bare electrode for arc-welding. It may be interestig along that line to show the quality of it, that the Boeing Airplane Company until only two or three years ago used that bare electrode for all the welding they did in their production of airplanes.

Q. In other words, the use of bare metal electrode in arc-welding is not obsolete?

A. No. It is still being used.

Q. In the use of bare metal electrode is any precaution ordinarily observed or sought to be adopted to render the arc stable, other than it would exhibit if it were a clean, bare rod?

A. In general there is put on the outside of the rod a certain amount of lime or material of that kind which will easily establish the arc and maintain it.

1219 In the use of wire as it is drawn, the drawing compound is still—enough of it is retained on the rod so that the rod itself can be used for that purpose with entire success.

An entire arc which is perfectly clean, in which there is nothing else except the iron, will not maintain easily, or with very great difficulty is the only way it can be maintained at all.

Q. This coating that you are now describing as used on what is otherwise known as bare metal weld rod is a very thin coating, is it not?

A. A very thin coating. What we call a wash coating. The material is merely dipped in it.

Q. The term "coated weld rod" is not ordinarily applied to that type of rod?

A. No.

Q. What do you mean by a coated metal weld rod as used in the industry?

A. The first step that was taken toward improving the quality of the weld, and it came rather slowly because of the fact that the bare electrode make a weld between two plates, for instance, which is still stronger than any riveted joint you can make, and therefore obviously since the
1220 riveted joint had been entirely successful, the fact there was a process whereby you could make it a little stronger than the riveted joint was of comparatively small importance in the minds of the enginners at that time, so herefore getting away from the bare electrode proceeded rather slowly—the thing that really put it across, and I can speak with authority on this because I handled the proposition at the time, the thing that put the coated electrode, as we may call it, the shielded arc elegtrode across, was the fact you could weld more than twice as fast with the shielded arc electrode as you could with the bare electrode.

That was the decisive factor in bringing the shielded arc electrode into commercial practice, and now I would say well over 90 per cent of all welding is done with the shielded arc electrode; and in fact I will include all automatic welding also.

Ninety per cent of it is still done with the shielded arc electrode because of the low cost and the excellence of the weld.

Q. In other words, the use of these coated weld rods, and we are talking now about the more heavily coated weld rod—

1221 A. Yes.

Q. —has not become obsolete?

A. Oh, great Scott, no! Practically all welding is done with it at the present time.

Q. Even since the advent of the so-called Unionmelt process?

A. Even after the advent of that process.

Q. Just by way of illustration, what did the sales of these coated weld rods amount to in pounds during the war period?

A. The actual production ran well over 85 million pounds per month.

Q. Per month?

A. Per month.

Q. For a period of—

A. For a period of years.

Mr. Cahill: Are these industry figures?
Mr. Oberlin: I do not know.

By Mr. Oberlin:

Q. Are these figures that are published, publicly known, Mr. Lincoln?

A. I think that the majority of it is industry figures. There are a certain number of manufacturers who do not report, but the vast majority of it is reported through
1222 the National Electrical Manufacturers Association, and becomes public property.

Q. And the data that you have just given as to the production of this particular product, this type of weld rod, is based on that published information?

A. That is correct.

Q. Were these coated weld rods used in shipbuilding, about which we have heard some testimony as to the use of the so-called Unionmelt process?

A. They were, and they were the reason why the tremendous number of ships that were welded were produced.

Q. Is that where a good portion of these millions of pounds per month went during the war period?

A. I do not know the distribution of these 85 million pounds a month, exactly. I would say probably 25 to 30 per cent went into shipbuilding. Gun mounts were made that way. Tanks. Jeeps. All the various war material, almost without exception, that was made out of steel was welded.

1223 Q. This production during the war period of coated weld rod: approximately what percentage or what proportion of that did your company supply?

A. Between 25 and 30 per cent.

Q. Now you have stated that the development of the coated wed rod, speaking now of the heavily coated type, was a somewhat slow proposition.

Will you just trace that history for us, briefly. What was the first form of such coated weld rod, that you know about?

A. The first form of coated weld rod which came out for commercial use, was made by the Quasi Arc people, in England.

That was made—I saw the first one of those, as I remember it about 1914, that was brought over to this country at that time, and was experimented with I think rather largely.

Q. And what was the nature of the coating on that rod, as nearly as you can remember?

A. The coating was largely silicates, which would form the same kind of slag we have been talking about here for the last ten days, on the metal, to protect it against the action of the air.

1224 The rod itself had a very thick coating of this material on it, so that when you finished with the rod, there was the same sort of slag melted on top of the weld as we have seen in the tests which have been made. That was used in this country to a slight extent, and to a very slight extent. I imagine that less than one per cent of the welding which was done in this country was done with the Quasi Arc material.

Q. And did that begin at or about the time to which you have referred, in 1914?

A. About that time.

Q. Well, before World War I?

A. Yes, sir.

Q. Yes?

A. And then in 1929 our company brought out for the first time commercially, a shielded arc electrode, which was fundamentally the same thing that the Quasi Arc was, with one exception, and that was that we added the idea not only of protecting the metal with molten slag, such as the Quasi Arc had done, but we also added to that the use of a cellulosic material, which, under the heat of the arc, would form a large amount of carbon monoxide,

1225 which would actually burn to dioxide, when it became exposed to the air, and hydrogen, which would shield the arc from the action of the air, because of the fact that that was the gas which would be formed there.

So that we had in that case both the action of the gas, shielding, and the action of the slag, shielding, so that when we finished, there was the slag coating covering the deposited metal, but the shielding had been done to a considerable extent by the use of the gas which had been formed in the heat of the arc.

Q. Was this silicate coating which you say characterized the Quasi Arc rod, a relatively refractory material?

A. Was it what?

Q. Was it a relatively refractory material melting at a fairly high point?

A. Oh, yes.

Q. And what about its action when the rod was actually used in the welding; what happened to this coating?

A. It melted down as the electrode melted down, and became the material which was deposited on the molten metal, on top of the molten metal as it was deposited, and protected it from the action of the air at that point.

1226 Q. Did any such coating afford any protection for the metal in the course of its being transferred, in the arc, from the end of the electrode to the work piece?

A. Oh, undoubtedly it did, but just what the division between the shielding which took place because of the gas, and the shielding which took place because of the molten slag would be, is a matter of question.

The Quasi Arc people were successful to a limited extent, limited by the matter of speed, and they were successful to a considerable extent in protecting the metal from the action of the air by slag alone.

We were able to increase very materially the speed of welding, by adding the protection of the inert gas, or relatively inert gas, and the action of the slag, too, combining them both.

Another thing which had a good deal to do with the success of it was the fact that the Quasi Arc electrode was sold, either because it was necessary, or for some other reason, at extremely high prices, so that it was not possible for the usual welding to be done economically with it. Bare welding was a more economical way of doing the job.

1227 Therefore the former had very little use.

We were able to reduce the cost of the welding rod to a point where it was practically no more than the cost of the bare rod which had been previously used.

Q. You are speaking now of the later developed form of coated weld rod that was put out by your own company; is that correct?

A. Yes.

Q. What was its name?

A. Fleetweld.

Q. That was its trade-name?

A. Yes, sir.

Q. And the figures which you have given as to the production of your own company, of coated weld rod, relate to that type of coated weld rod; is that correct?

A. Yes, sir.

Q. Under that name.

A. Yes, sir. We manufactured it for a matter of several years, alone.

It was only two or three years after the beginning of the operation, that any one else, except ourselves, pro-
1228 duced it.

Q. Was the manufacture of this coated weld rod of yours challenged under any patent at the time you began to manufacture it?

1230 A. Yes.

1233 Mr. Oberlin: I cite the Court's attention at this time to the case of *A. O. Smith Corp.* v. *Lincoln Electric Company*, as reported in 82 F. 2nd 226, that report being the opinion of the Court of Appeals for the Sixth Circuit, which terminated the litigation.

1235 Q. Is this method of protecting the arc by putting a coating on the weld rod, applicable to the carbon arc process?

A. You cannot put it on the carbon, no, sir.

Q. You might describe a little more fully for the record how the carbon arc weld process is conducted.

A. In the case of the carbon process,—for instance, if this were the part that was being welded (indicating), and this would be the carbon—

1236 Q. You are now holding up a pencil—

A. A pencil.

Q. —about an inch?

A. About an inch above the part to be welded.

Q. Continue.

A. Then the current, the direct current, is brought in through the work to be welded, up to the carbon, and at the point of weld, there is a large amount of heat liberated, which will melt the plate.

Then additional material can be fed in, as it has been in our case, automatically, or as it has been done in many cases, by hand, by putting in a bar, or a rod, which would be melted in the heat of the arc, and added to the metal already melted by the arc itself, in the parent metal.

Q. And such additional metal is called filler metal; is that correct?

A. Yes, sir.

Q. And it is necessary in this case—well, will you please state why such filler metal is added in this form when you are welding with a carbon arc, and not in the case of the metal weld rod.

1237 A. Of course, in the case of the carbon arc, there is a void in there between the two, or else there would be a continuous piece; and you use that metal, to fill the void, which is necessary in order to build the weld up for the full section of the parts to be welded.

In the case of the metal electrode process, which is operated fundamentally in the same way, the melting by the electrode itself furnishes the filling material.

Q. Why is the use of a coating applied to the carbon electrode, or rod, not practical?

A. Because the carbon electrode would melt off so very slowly, and under those conditions it would be impossible for a sufficient amount of coating material to be supplied to the weld, in order to protect it.

Q. Is there any other method known to the industry of protecting the weld metal in arc-welding, either using the carbon arc or the metal arc, than thus coating the weld rod as you have described?

A. There have been both of the fundamental claims which I spoke of before, of furnishing a protective gas, and also protective slag.

1238 The slag would be the same sort of slag as has been used by the steel industry for generations, which has a silicate on the surface of the material, to protect it from the action of the air, and, in the case of welding, it would be the furnishing of the gas, as I have already outlined, for the protection of the metal by the gas itself, which would not affect the metal.

Q. Well, just how is this fluxing material applied, where you do not put it on the rod as a coating?

A. It is laid on the weld, at the point to be welded.

Q. And how long has that method of production been known in the industry—I mean, commercially?

A. Oh, it has been known and used for many, many years.

Q. Well, how far back have you used it in your own company?

A. We used it ourselves back to the early 20's; that is, before 1923.

We welded a pipe line, the Mokelumne River pipe line, in California, which brings all of the water to the cities of Oakland, Alameda, Richmond, and Berkeley, which is 100 miles long, and some 65 inches in diameter, with two longitudinal welds in each piece of pipe, and varying

1239 in thickness of wall from 3/8ths of an inch to 3/4ths of an inch.

That was all welded by the carbon arc process, and it has been in operation now since 1926 with entire success.

Q. And the carbon arc process, as you thus used it in this particular project, as well as generally, your employed a flux, as I understand it, laid along the seam of the pipe to be welded, did you?

A. That was true.

Q. Was there any other additional protecting material or medium?

A. No.

Q. (Continuing) Than the flux which you laid along the seam?

A. No.

Q. Is there any other way of producing a protective medium in the carbon arc process, except by putting the material directly on the seam?

A. Oh, we feed—we can feed into the arc, a cellulosic material, which has been done in many, many cases, which will form this protective gas, and which will exclude the weld from contamination of the metal.

1240 Q. Is that supplemental to or in conjunction with the protection afforded by the flux which is laid right along the seam?

A. It could be either, or both.

Q. Where you want to put additional weld metal into the carbon arc continuously, how is that done?

A. That is done by feeding a wire into the arc, so as to add any amount of metal which you may wish to add.

Q. By the way, is supplemental weld metal, or filler metal, added in a similar manner, when you are welding with a metal weld rod?

A. Yes, sir, that has been done in many cases.

Q. And in particular, what kind of supplemental metal has been thus used, and for what purpose?

A. Generally it is a bar or a wire. In other words, in heavy welding, very frequently, the arc being between the shielded arc electrode and the plate, there will be fed into it at the same time additional material, so that the welding will proceed more rapidly.

1241 Q. Is that additional material of a different composition, metallic composition, than either the base plate, the work piece, or the electrode?

A. Yes.

Q. With what object?

A. To change the character of the weld metal, or for any other reason you may have. The cleansing of it could be done by feeding in certain alloys, either in the flux or in the added material.

Q. Was this process which you have described for protecting weld metal—you described it particularly in connection with the use in carbon arc process—patented?

A. Yes, sir.

Q. Can you identify the document which I hand you, a printed document?

A. Yes. That is a patent we own, issued to J. C. Lincoln, who is the chairman of the board of the company.

Mr. Oberlin: I ask that this be marked for identification as Defendants' Exhibit 101.

1242 (Whereupon the said document was marked Defendants' Exhibit 101 for identification.)

By Mr. Oberlin:

Q. This patent, I note, was issued June 15, 1926, and the term of a United States patent being 17 years, has therefore expired several years ago.

Was it owned during its term by your company?

A. Yes.

Q. What was the trade name under which you sold and still sell electric welding equipment designed for use of the carbon arc, in contradistinction to the metal?

A. Electronic Tornado.

1245 Q. In the process of the John C. Lincoln patent, as you understand it—I am speaking now of the disclosure, the teaching of the patent, disregarding the claim—is there any description or teaching of the use of the metallic electrode?

A. Yes.

By Mr. Oberlin:

Q. Where did you see a commercial installation or operation of electric arc welding in which a metallic electrode was employed and flux was utilized in the form of a layer deposited along the seam to be welded?

A. At the National Tube Company in Pittsburgh.

Q. When did you see that operation, Mr. Lincoln, approximately?

A. About '31 or '2, along in there. I don't remember; that was a long time ago.

1246 Q. It was in the early 30's? You are positive of that?

A. Yes, I am positive.

Q. Where was the plant you visited on this occasion?

A. National Tube Company, Christie Park, a suburb of Pittsburgh.

Q. Is that also known as the McKeesport plant of the company, or do you know?

A. If it is, I don't know.

Q. You know it as the Christie Park plant?

A. I know it as the Christie Park plant of the company.

Q. Describe what you saw there, how big a plant, how it was set up, what it was designed to make.

A. It was designed to make pipe which, at the time I saw it, was about two feet in diameter.

There were a number of heads, I would say 25 or 30 of them, in operation, in which the pipe was rolled up into a cylinder, then the pipe was passed underneath a stationary arc by a carriage that brought it along.

As the pipe approached the arc, there was put onto it a deep bed of flux, which acted as the shielding mate-

1247 rial for the welding.

Q. How long were these pipe sections that were being welded, approximately?

A. I would guess—

Mr. Cahill: I object to guessing.

By Mr. Oberlin:

Q. What is your best estimate?

A. 25 or 30 feet.

Q. And the diameter?

A. Around two feet.

Q. And this flux material that was deposited, as you examined it, as far as you observed, what was its nature?

A. It looked like clay, white sand.

Q. In what form?

A. Rather finely divided. It was very fine.

Q. How was it deopsited on the seam?

1248 A. It came down a chute on the plate just in front of the weld.

Q. Where was the lower end of the rod or wire you stated was fed into the flux, as far as you observed?

A. It was underneath the flux.

Q. Could you see the end—

A. No.

Q. —during the operation, I mean?

A. No.

1249 Q. Was there any evidence of an arc being in existence between the end of that electrode and the weld work piece?

A. Surely.

Q. What was the effect of the flux, what action did it have with respect to the arc?

A. It submerged it and was deposited on the material after it had come through the arc, back of the weld, where it was blown by the power of the arc and formed a coating on the material, the same as you have in all—

Q. You may use an analogy if you wish.

A. In exactly the same way as a metallic hand arc is done. The action is identical.

Q. You have described, at least in part, the operation which you witnessed at the Christie Park plant of the National Tube Company back in the early 30's, 1931

1250 or 1932, I believe you said.

A. Yes.

Q. In that connection you have referred to the deposit of a layer of flux along the seam to be welded, through which layer or into which layer the end of the weld rod extended.

A. Yes.

Q. How was that weld ~~rod supplied~~, and what was its character?

A. It was fed off a reel.

Q. Like a continuous length of wire?

A. Yes.

Q. Do you know what kind of a weld head? You spoke of a weld head that was utilized for thus feeding the wire.

A. My remembrance of it was General Electric. I know the motor generators that furnished the current were General Electric. I am quite sure the heads were, too, although they may have been redesigned or changed to some extent for that particular job by the National Tube Company.

Q. Were there a number of those machines utilizing these heads?

A. My remembrance of it is that there were quite

1251 a number, twenty-five or thirty.

Q. What was the condition, so far as you observed

it, at least, of the flux following the weld rod in the direction of movement of the parts relatively to each other?

That is, what was the condition of the flux after the welding operation?

A. It fell back, or came down, or remained on top of the molten slag which remained on top of the metal. In other words, if you went down after you had finished the weld, you would go through the unmelted slag into the melted slag into the hardened metal, the frozen metal.

Q. Did you meet anyone there whom you recall by name?

A. Mr. Robinoff I met there.

Q. What was his connection with that operation, if you know?

A. As I understood it, he was the superintendent of the plant.

Q. That was Mr. Boris Robinoff?

A. Yes.

Q. There has been some discussion of hand welding versus automatic welding in the course of testimony heretofore given in this case. What is the form of 1252 weld rod used in hand welding?

A. It is about fourteen—most of them are either fourteen or eighteen inches long. The larger diameters, generally, are from a quarter inch, and larger, are eighteen inches long. Those from a quarter inch or smaller in diameter are fourteen. Generally the quarter inch is made in both lengths.

Q. You witnessed a demonstration with a holder produced by Plaintiff earlier in the course of the Plaintiff's proof?

A. Yes.

Q. Here in the court room, I mean.

A. Yes.

Q. Was that a typical holder?

A. Yes.

Q. Such is used in manipulating the weld rod?

A. That is the commercial form that is now being sold.

Q. Is the weld rod, coated weld rod that your have described, used in the same manner? That is, in hand welding?

A. Yes.

Q. Held by an electrode holder?

A. Yes.

1253 Q. All of this weld rod that you have described as being currently produced, both bare and coated, is handled that way?

A. Yes.

Q. Just how does the operator proceed with such weld rod in hand or manual welding?

A. He puts the electrode into the holder, the top end of it having had the coating taken off during manufacturing. He grips it there so that the current can flow through the cable which goes to that holder, down through the rod to the work, or in the other direction, depending upon conditions.

Then he brings the other end of the electrode down on the work, which will start a current to flowing. Then he will pull it away, as far as he should by skill, by his experience, to maintain the arc at the proper length, feeding it down as the electrode burns off and advancing it along the line of weld as is needed.

Q. That is true where the weld rod is bare or where it is coated?

A. The operation is identical.

Q. How does he gauge the distance that the end of the weld rod is to be held from the work piece?

1254 A. By experience.

Q. Well, I presume there is some instruction given.

A. In general you hold it—you have to hold it rather closely, or the arc breaks. If you hold it too closely, then the end of the electrode will freeze to the work, so that you have those two limits between which you are to hold it.

Now, it is true that with bare rod the length of the arc that is maintained would be shorter than with the coated rod, so that the coated rod again can be used with greater facility than the bare rod can. That is another reason why the coated electrode method of welding, the shielded arc method of welding is progressively more popular. It is easier to do. It is much faster, and there is some advantage in some cases as far as quality is concerned.

Q. What is automatic welding, in contradistinction to—

A. Automatic welding—

Mr. Oberlin: Pardon me.

By Mr. Oberlin:

Q. What is automatic welding in contradistinction to hand welding?

1255 The Witness: Automatic welding is doing exactly the same thing as hand welding, except for the fact that the feeding of the electrode is done by machinery, the advancing of the arc is done by machinery, and instead of having short lengths of electrode, in general a continuous rod is fed.

By Mr. Oberlin:

Q. Has automatic welding as you have just described it, and equipment available for carrying out such automatic welding, been known for some time past?

A. It has been known for at least thirty years, to my knowledge,—twenty-five years, to my knowledge. Twenty-five to thirty years.

Q. Who was one of the first manufacturers, if you know, to introduce an automatic arc welding machine?

A. The General Electric Company.

Q. Was the head or the equipment, including the head, which you saw at the National Tube Company plant as you have described it, the type of automatic welding machine thus made for some years by General
1256 Electric?

A. Yes.

Q. Is there any other process of welding—or let me ask you the question this way: Is there a semi-automatic method of arc-welding also known in the industry?

A. Yes.

Q. What is the nature of that process?

A. In semi-automatic welding, the difference between that and full automatic welding is the fact that the electrode is held in the hand of the operator who guides it. The feeding of the electrode itself is done by machinery, and that is the difference.

It is left to the judgment of the individual as to how fast he will advance the arc, and also it makes it possible for him to fill up depressions or things of that kind if he so desires.

Q. That is, if there is some point along the line to be welded where obviously more metal should be deposited than elsewhere, he can slow the advance of the weld rod along there?

A. Yes.

Q. Then what results?

A. He can fill it up so it will become full. There

1257 is one other very great advantage that comes from the semi-automatic or irregular operation. The preparation of the material for welding in the case of full automatic has to be exactly duplicated, or else the results will be variable. The cost of doing that in many cases will eliminate many times over the advantage which the automatic welding part of it would give.

For that reason hand welding is used in many, many cases because of the increased cost of preparation, in which automatic welding would be used, were that additional cost not necessary. The semi-automatic process makes it possible for you to overcome that difficulty.

Q. Well, in the matter of preparation, where an automatic welding operation is to be carried out, do you include such cost as preparing jigs to hold parts?

A. Every one of those, such as preparing the jigs, and preparing the edge itself, and the assembling of it so it is exactly the same as what the machine has been set up for. That is an extremely important matter. It is obvious, for the sake of argument, that in automatic welding 1258 if you have a groove which, we will say, is this big (indicating) and you set up for that, if by mistake the edges are allowed to get apart it will not fill the groove up completely, or if the angle is changed, it will not fill the groove up completely, or will overfill it; but with hand welding you automatically take care of that by the judgment of the operator.

Q. That would apply equally to what you have been discussing as semi-automatic welding?

A. That is correct.

Q. Now, in the use of the automatic welding equipment as put out by GE some twenty-five years ago, you say, what if any use has been made of fluxes or fluxing materials to protect the arc and the weld metal in the arc?

The Witness: There have been right from the—I would say almost from the first, there were attempts along that line made, mainly to maintain the arc more easily. Then came along the attempt to put in certain materials which would serve to some extent to smooth the weld 1259 itself. Titanium oxide, I believe, was one of them which was put in by notching the wire itself, running it through a series of rolls which would notch it, and then having the titanium oxide put in there by drawing it through a draw, or some other scheme of that kind.

1260 Such electrodes I think are still being sold and have been used to a considerable extent. It maintains the arc much easier, and it also may have—may have—some slight advantage in increasing the ductility of the metal, if greater ductility might be needed.

Q. In that case this fluxing material, do I understand you to say, was applied on the weld rod or by the weld rod?

A. Yes.

Q. I believe you have indicated the first use you have seen in metallic arc-welding of flux deposited along the seam to be welded was at the National Tube Company?

A. At the National Tube Company.

Q. When you visited it in the early 30's?

A. Yes.

Q. Is the operation any different, the welding operation, where you thus weld through a deposited layer of flux along the seam with an automatic head or manually?

A. Will you state the question again?

Mr. Oberlin: I will repeat it.

By Mr. Oberlin:

1261 Q. Is the operation any different, as far as protecting the weld metal is concerned, whether you operate the weld rod using one of these continuous or automatic machines, or do it manually?

A. Indentical, fundamentally.

Q. With respect to this semi-automatic type of operation, has that been known commercially for any length of time?

A. I would say at least 25 years.

Q. Substantially coincidentally with the full automatic?

A. Substantially the same.

Q. And introduced originally by whom?

A. General Electric Company.

Q. May I ask the same question as I did with respect to the comparison of operations between the automatic and the hand welding: Does it make any difference when you are welding through a prospective layer of flux disposed along the seam, whether it is done by hand welding or with one of these semi-automatic outfits?

A. Obviously there is no difference, because what the material does is to melt, the deposit being deposited on the metal at the time of melting and after the melting

1262 has been done. Whether you do it by hand or by semi-automatic or by machine operation obviously, as far as protection is concerned, is identical.

Q. I show you a duplicate of Plaintiff's Exhibit 203, which is a booklet identified as having been put out by your company, entitled "Lincolnweld—The New Automatic Shielded Arc Welding Process".

Is the word or phrase "shielded arc", as employed in there, employed with any different significance than you have used in your previous testimony regarded as shielded welding process or welding rod?

A. No.

Q. Is there, as a matter of fact, any difference in the manner or the results of the shielding obtained in this "New Automatic Shielded Arc Welding Process" from those obtained in the processes you have described where the coating has been applied—the flux has been applied in the form of a coating on the rod?

A. Commercially none; technically, there might be slight variations.

Q. In connection with the book just identified by you and which bears the title which I quoted,
1263 there has also been marked for identification, during the taking of your deposition as an adverse witness by plaintiff some time earlier in this case, a bulletin LAF-1, describing the Lincolnweld process.

Are you familiar with that in general?

A. Yes.

Q. This particular bulletin that I have last called your attention to is published and used for what purpose, Mr. Lincoln?

A. Instructions for both the salesmen and the people that will use the process.

Q. In this bulletin, Section 1, page 9, occurs the following statement in reference to the flux which is to be used in this Lincolnweld process; and before quoting that, what is the trade designation of that flux, if you remember?

A. 660.

Q. The statement that I am calling your attention to reads as follows:

"Lincolnweld Flux No. 660 is a fused complex metallic silicate to be used when welding mild steel, and low alloy

high tensile steels, straight chrome, and chrome nickel
1264 steels.

"As supplied, Flux No. 660 has the following screen analysis," and there is then given the analysis; and I call your particular attention now to this further statement:

"When welding, use enough flux to submerge the arc only. There will be no harmful effect on the weld if the arc does break out of the flux slightly once in a while."

Is that in accordance with prescribed practice and use of the Lincolnweld process?

A. Yes.

Q. And is the statement there made about there being no harmful effect if the arc does break out, true as far as you know?

A. Yes.

Mr. Oberlin: We have been unable to identify the original copy from which photostatic copies were made for the use of counsel. That was held by plaintiff's counsel, necessarily, because they took the deposition originally.

I offer this photostatic copy which has been provided us by counsel, as Defendants' Exhibit 102.

1265 Mr. Cahill: No objection.

The Court: Admitted.

(Whereupon the said document was marked DEFENDANTS' EXHIBIT 102 and admitted in evidence.)

Mr. Oberlin: I also take this opportunity of offering the Lincolnweld patent number 1,589,017, as Defendants' Exhibit 101.

Mr. Cahill: No objection.

The Court: Admitted.

(Whereupon the said patent was marked DEFENDANTS' EXHIBIT 101 and admitted in evidence.)

By Mr. Oberlin:

Q. In the statement which I quoted from this bulletin, now Defendants' Exhibit No. 102, this flux No. 660, is described as a complex metallic silicate. Do you know what the principal ingredient, silicate ingredient, is as now compounded?

A. Yes, manganese and silica, with the addition of fluorspar.

Q. Well, the manganese and silica, are they there separately or combined?

1266 A. No, they are melted in an electric furnace, with the fluorspar.

Q. All these ingredients?

A. All of them.

Q. Do you know whether the selection of manganese silicate as the principal constituent in the finished flux has any particular significance?

A. I do.

Q. What effect, beneficial or otherwise, does the composition of the flux in the state of manganese silicate present?

A. The presence of manganese in proper proportions, going into the steel as it is being welded will eliminate the reaction of the carbon and oxygen in the steel. The reaction of carbon and oxygen in the steel is a bad thing for welding, because of the fact it will form a gas.

1287 Sometimes other reactions form solids. The reaction of manganese with silicon, or with oxygen, will not form a gas, but will form a solid.

If a gas is formed, there is a tendency toward porosity. If a gas is formed, and instead of that, you have a solid, you would have, as with manganese oxide or with manganese silicate, a solid which will float out into the slag if it has time enough, or will remain as a solid of very small dimension in the weld itself.

Q. Do you base the observations which you have just made—or rather, do you base the statements which you have just made upon observations of results actually obtained in commercial use?

A. Yes, sir.

Q. You are not just explaining this in any theoretical way, are you?

A. No, sir, I am not, not by any stretch of the imagination.

Q. Have you had occasion to observe any difference in the respect which you have just described, between a flux such as your own, your 660, and the flux in which the predominant or major constituent is calcium silicate, instead of manganese silicate?

1269 The Witness: The manganese silicate flux will weld successfully, that is, will weld without porosity in many cases where the other type of flux would give porosity.

Those cases would be the obvious ones, three in number. The first is where you have a good deal of iron oxide on

the plates, which has not been removed. The second is where you have any oil or oily dirt. The third is where you have an excess of moisture.

In the case of manganese silicate slag, such as 660, you can weld under conditions under which it would not be possible to weld without porosity with the other slag—or the other fluxes.

By Mr. Oberlin:

Q. Have you observed any other differences—

1270 Q. (Continuing) —in actual performance,—in the welding that you have observed, in actual performance?

A. Well, I know of no other differences.

Q. Well, in this statement in your bulletin, reference is made to the adaptability of your Lincolnweld Flux No. 660, to welding quite a variety apparently of steels; welding mild steels, low alloy high-tensile steels, straight chrome and chrome-nickel steels.

Is there any variation required in the composition of your 660 flux, thus to adapt it to the welding of these different steels?

A. No.

Q. In the case of a flux in which the major constituent is calcium silicate, is that true?

1271 A. In the welding of any steels, the same thing will occur. You can eliminate the deleterious effects of the oxides on steels; you can eliminate the deleterious effects to a large extent of dirt, and oil, and moisture.

Mr. Cahill: I take it, your Honor, that these are

1272 offered as personal observations.

The Witness: Yes, sir.

1273 Mr. Oberlin: If your Honor please, at this time I offer in evidence a copy of the Robinoff, et al patent, No. 1,782,316, dated November 18, 1930.

Mr. Cahill: No objection.

The Court: Admitted.

(Whereupon the said patent was marked DEFENDANTS' EXHIBIT 103 and admitted in evidence.)

1274 JAMES FINNEY LINCOLN, called as a witness on behalf of the defendants, having previously been sworn, resumed the stand and testified further as follows:

Direct Examination (Continued) by Mr. Oberlin.

Q. Mr. Lincoln, you have known of this Robinoff patent, have you?

A. Yes, sir.

Q. Has your company obtained a license under this patent?

A. Yes.

Q. The owner of the patent being whom?

A. National Tube Company.

Q. The same company whose plant you visited back in the early 30's?

A. Yes, sir.

Q. And the Robinoff named in here? Do you know whether or not he is the same Robinoff whom you testified you had met on the occasion of your visit to the plant?

A. He is.

1275 Q. Mr. Lincoln, do you have any familiarity with electric arc furnaces, so-called?

A. Yes.

Q. In a general way, what is the principle of operation of such furnaces?

A. It is a means for heating steel with the electric arc. It is put into a container—that is, the steel is put into a container, generally as cold scrap, or as, perhaps, melted iron, or melted steel, and then there is a flux put over the top of it, and the arc is played on the steel.

It is essentially the same operation that we have in the case of this welding operation here, except that, in the case of the electric furnace, the arc remains stationary relative to the work, while in the case of welding, it moves on.

1276 Q. In the electric arc furnace, of what material is the electrode ordinarily?

A. Made generally out of either carbon or graphite. Both are used.

Q. There would be, then, the further distinction between electric arc furnace welding and that you referred

to as being before you here,—and by that you mean the welding under deep layer of flux, is that it?

A. Yes.

Q. There would be the further distinction of a metallic electrode instead of carbon or graphite?

A. Yes, that is true. Of course, you do have a carbon electrode used and the graphite electrode used in the arc-welding; also.

Q. In the course of the taking of your deposition, now nearly a year ago, you were questioned about the J. F. Lincoln Arc Foundation. I believe I have the name correct.

A. Arc Welding Foundation.

Q. Arc Welding Foundation. What is the nature of the foundation, and where was it established? Give us briefly an account of it, and its objective.

1280 A. The Lincoln Foundation was established by the directors of the Lincoln Electric Company as a means of developing new information, education, and the spur of reward to people who would develop new information in connection with arc-welding and its application.

By Mr. Oberlin:

Q. Where is the Foundation established?

A. Headquarters in Cleveland.

Q. Has the Lincoln Electric Company any direction of the operation of the Foundation?

A. None whatsoever.

Q. Has the Foundation anything to do with the award of gold medals concerning which certain of plaintiff's witnesses have testified?

A. Nothing whatsoever.

Mr. Oberlin: That is all. You may cross-examine.

Cross-Examination by Mr. Cahill.

Q. You are familiar with the Welding Handbook, are you not?

A. That depends on what you mean by "familiar".

Q. You have read it, I take it.

1281 A. No. I have not read it all.

Q. You have read parts of it?

A. I have read parts of it.

Q. This definition of resistance welding appears at page 269 of the Welding Handbook, 1942:

"Resistance welding embraces that branch of the welding art in which the welding heat in the parts to be welded is generated by the resistance offered by these parts to the passage of an electric current. It differs from other forms of welding in that no extraneous materials, such as fluxes, filler rods, etc., are used, therefore the metallography of the weld is not complicated by the addition of these materials."

Do you agree with that definition?

A. I would say it is true, yes.

Q. You were in court, were you not, when counsel opened the case to the Court?

A. Yes.

Q. One preliminary question. Under the definition that I have read I take it that neither the Lincolnweld nor the Unionmelt would be classed as resistance welding, is that true?

1282 A. That is correct.

Q. Now, you say you were in court when counsel opened the case, and I ask you if you heard counsel for the defense state to the Court as follows, page 90:

"Now, just in that connection there are two methods that are used, two electrical methods, for the generation of heat for welding. There are two and there are only two. One is the electric arc—that is the process that the defendants use—and then there is the other electrical resistance, and that is what Jones has."

Now, did you hear counsel for the defendants make that statement in opening this case to the Court?

A. I do not remember.

1285 Q. Do you agree with the statement that I just read to you?

A. I would like to hear the statement again.

Q. Yes, I shall be very glad to read it to you. I am reading now from page 90 of the transcript:

"One is the electric arc—that is the process that the defendants use—and then there is the other, electrical resistance, and that is what Jones has."

1286 The Witness: Will you read that again, please, and go back to where it starts.

By Mr. Cahill:

Q. I am reading the entire paragraph, now.

A. Good.

Q. (Reading.) "Now, just in that connection there are two methods that are used, two electrical methods"—

A. Just in what connection? Will you go back to the antecedent of that, please.

Q. Yes, indeed.

"In one case"—and I am reading the entire paragraph preceding, now—"of the accused process"—

A. Of what process?

Q. "The accused process."

A. Yes.

Q. "—we definitely have a gaseous medium extending between the movable electrode and the base metal.

1287 "In the Jones process he does not have that. He has the conductive melt, which is the flux, to carry the current which heats this molten metal, which in turn conveys the heat back to the electrode and to the parent metal."

Now, I am reading the paragraph again to you, that I read before:

"Now, just in that connection there are two methods that are used, two electrical methods, for the generation of heat for welding. There are two, and there are only two. One is the electric arc—that is the process that the defendants use, and then there is the other, electrical resistance, and that is what Jones has."

Now, I ask you whether or not you agree with that statement?

A. Well, now, you have got, first of all, to get back to the patent itself.

Mr. Cahill: May I have an answer to my question, may it please the Court? I think before there is any explanation, I am entitled to know whether or not

1288 the witness agrees with the statement I have just read him.

The Court: You may answer the question first by yes or no, and then, if it requires an explanation, you may finish out your answer with your explanation.

A. Well, that statement without an explanation, is indefinite.

By Mr. Cahill:

Q. Well, let me read you something from page 93, and I am quoting:

"I emphasize that word 'resistance' because just a mom-

ent ago I spoke about the two types of electric welding, one, arc-welding, and the other, resistance welding."

Now, does that additional statement make the earlier one somewhat more definite?

A. Well, there are two types of welding—

Mr. Cahill: No; answer the question, please Mr. Witness.

The Witness; What is the question?

By Mr. Cahill:

Q. Does the second statement make the first one somewhat more definite?

1289 A. Not at all.

By Mr. Cahill:

Q. Now, will you tell me whether or not you agree with the statements that I have read?

A. Which statements?

1290 Q. Both statements, the first statement, and the second statement.

A. Well, now, there were a number of statements which you read. Just which particular statement do you refer to?

Q. Well, I will ask you specifically with regard to this sentence appearing on page 90 of the transcript, and I will ask you if you agree with this statement:

"One is the electric arc,—that is the process that the defendants use; and then there is the other, electrical resistance, and that is what Jones has."

Now, I am asking you, do you agree with that statement?

A. That cannot be answered unless the whole argument that counsel made is brought out. Now, I can answer the question, if you want that question answered. Do you?

1291 Q. Now, will you please answer the question that I put, and not ask me questions, and may I have an instruction to that effect, please, your Honor?

The Court: Yes. I think if the question is objectionable or indefinite, your counsel can so indicate.

The Witness: The statement as it stands, I do not.

By Mr. Cahill:

Q. Now, this morning you testified that the manganese silicate flux, referring thereby I take it to Lincolnweld—is that true?

A. I referred to the 660 flux this morning, yes.

Q. (Continuing) —will weld successively, that it without porosity, in many cases, where the other type of flux would give porosity. These cases would be the three
1292 obvious ones: First, where you have a good deal of iron oxide on the plates which has not been removed. Second, where you have any oil or oily dirt. Third, where you have an excess of moisture. Do you recall giving that testimony this morning?

A. Yes.

Q. Now, is it not the fact that in giving instructions for the practice of the Lincolnweld flux that you instruct your operators that moisture, rust, scale, oil and grease must be removed and that the joint edges must be clean of all foreign matter?

A. It is a matter purely of degree.

Q. Do you give such instructions? Will you please answer my question?

A. I did.

Q. Those instructions are given in writing, are they not?

A. What instructions?

Q. That, and I quote, "joint edges must be clean of all foreign matter such as moisture, rust, scale, oil and grease and paint primer"?

A. That is true.

Q. Now, what process of electric welding used
1293 commercially prior to June 9, 1936, butt welded plate 2½ inches thick in a single pass?

A. I know of none.

Q. What process of fusion welding used commercially prior to June 9, 1936 on butt welds employed currents of 2000 amperes and above?

A. None that I know of, commercially.

Q. What process of electric welding used commercially prior to June 9, 1936, butt welded 12 gauge plate at the rate of 120 inches per minute?

A. I know of none.

Q. What process of electric welding used commercially prior to June 9, 1936, welded with 600 amperes with a ⅛ inch electrode without any visible evidence of a welding operation going on?

A. The Robinoff process.

Q. The Robinoff process, to your mind, is one that

operates without any visible evidence of a welding operation going on?

A. That depends on what you call "visible evidence."

Q. Well,—

A. (Continuing) Of course, if you have a welding machine in operation, there is visible evidence of a welding operation going on.

1294 Mr. Cahill: I ask that it be answered directly.

The Witness: It does not.

By Mr. Cahill:

Q. It does not?

A. It does not.

1302 Q. What effect did the Unionmelt process and the sale of the Unionmelt flux have on your business?

1303 The Witness: I have no way of knowing.

By Mr. Cahill:

Q. Now, do you recall the identical question having been put to you on your deposition, page 176, and your making the answer as follows:

"A. It reduced in certain places the application of both hand and automatic welding."

Do you recall giving that answer?

A. Yes.

Q. Do you recall—let me put you this question:

1304 To what extent did Unionmelt cut into your business?

A. Infinitesimal.

Q. Do you recall that question being put to you at page 177 and your making the answer thereto:

"I would say that on certain types of business it affected it to a very considerable extent."

A. Correct.

Q. Do you recall making that answer?

A. I do.

1305 What has been the effect of the Unionmelt process and flux on your business, Mr. Witness?

A. You mean, as to volume of business?

Q. Yes.

A. Well, it is impossible to answer that question accurately. You see, the actual amount of business which we did in the automatic field was never more than one to two per cent of our total business.

1306 Therefore if we lost it all, or if we neglected it,

did nothing with it, as was true in after years, obviously it would have no effect of any appreciable extent on our business.

Q. Now, I put you the question: What has been the effect of the Lincolnweld process and flux on your business?

A. It has increased it to a rather small extent.

Q. How did it, meaning Lincolnweld, bring back the total business you were doing?

A. Automatic welding has always been an infinitesimal part of the total. In other words, in a business of $33,000,000, $100,000 cannot be a very important item.

Q. Well, do you recall—

A. Because that is an amount of business which you do in less than a day.

Q. Do you recall that question having been put to you on page 177 of your deposition, and your answering it this way:

"It did not bring it back. Our proportion of the total business was very much less since this Linde process, that is, this deep flux process, has been going than it was prior to that time, very considerably less."

1307 Do you recall making that answer?

May I see that, and go back of that and see what is before it?

Q. Do you recall making that answer?

A. No. I do not recall that. I do not recall at all.

Q. Let me just show you the transcript.

A. I would like to see it.

Q. The answer that is marked there (Indicating).

Q. Did you make that answer, Mr. Lincoln?

1308 A. That is correct, referring to automatic welding, you understand. That is what the context before shows. It never has been a large part of our business, automatic welding.

By Mr. Cahill:

Q. Now, you are the president and as well the chief executive of the Lincoln Company, are you not?

A. That is correct.

Q. You and your family own substantially all of that company, is that not true?

A. That is not correct.

Q. Will you tell me what the fact is, please?

A. The fact about what?

1309 I own slightly over three per cent of the stock of the Lincoln Electric Company.

By Mr. Cahill:

Q. How is the rest of it owned?

A. How much what?

1310 Q. How is the rest of it owned?

A. It is owned by the people in it, almost without exception.

Q. Who are they?

A. There are about eight hundred—about 450 stockholders, most of which are—the vast majority of the stockholders are people that work by the hour in the organization.

Q. What percentage of the stock do they own?

A. Who is "they"?

Q. The people you last described.

A. Well, I do not know. I would say somewhere in the neighborhood of ten per cent, if you take the people who work with their hands, production workers.

Q. They own ten per cent and you own three. Who owns the other 87 per cent?

A. There is a matter of four or five hundred other stockholders.

Q. Who are they?

A. I have not got a list of them.

Q. Are they a scattered group?

A. A scattered group?

Q. Yes.

A. You mean by "a scattered group", what?

1311 Q. That they are not identified as workers in the plant, as you described the preceding ones.

A. I said the vast majority of the stock, I would say well over 80 per cent, is owned by people who spend all of their time in the Lincoln Electric Company.

Q. Now, you have told us that you own three per cent, and you have told us that those who work in the plant own ten per cent; right?

A. That is right.

Q. Now, you say there is another group of 500, is that right?

A. That is right.

Q. Now, I ask you: What percentage of stock does that other group own?

A. They would own the difference, less about 20 per cent which is owned by people who are not connected with the company. I said, men that worked with their hands, production workers. Now then, you have also office workers. You have such people as engineers, such people as officers of the company and people of that kind who are in it.

Q. Do you have trusts, Mr. Lincoln?

A. Do I have trusts?

1312 Q. Yes. That you have created?

A. Yes. I have a trust.

Q. What percentage of the stock is in those trusts?

A. Approximately one-third.

Q. 33 1/3 per cent?

A. You asked me what proportion of my stock—

Mr. Cahill: Just a minute.

By Mr. Cahill:

Q. Is there 33 1/3 per cent of the capital stock of this company in trusts of which you were the creator?

A. No.

Q. What did you mean by your answer a moment ago that one-third of the stock—

A. You asked me what proportion of my stock, that I had originally owned, I inferred, was in trusts.

Q. What—

A. I answered approximately one-third.

Q. What percentage of the stock of this company is owned by your brother?

A. Approximately—wait a second. Approximately six per cent.

Q. And by members of his family, how much?

A. You mean, by his wife and children?

1313 Q. Yes.

A. I would say approximately eight to ten per cent.

Q. How much does that give him, about fifteen per cent?

A. Give him?

Q. And members of his family.

A. I would say it would be more than that. Around 20 or 25 percent. I have not got the figures in front of me.

Q. 20 or 25 per cent. You own 3 per cent?

A. I personally have 3 per cent.

Q. How much do members of your family have, both directly and beneficially?

A. Approximately 30 per cent.

Q. And that is in addition to the 20 or 25 per cent that your brother has?

A. That is right.

Q. That accounts for about 58 per cent of the stock, does it not?

A. Somewhere around 60 or 65 per cent.

Q. Is there any other stock owned by any other relatives of you or your brother?

A. What do you mean by "any other relatives"?

Q. Well, just what you mean in ordinary life, cousins, sisters, brothers, aunts; just exactly what you
1314 use in ordinary speech.

A. Well, I do not know how far back to go.

The Court: The objection is overruled. Read the question again, please, Mr. Reporter.

(The question was read.)

A. No.

By Mr. Cahill:

Q. You have control through your brother and his family, and your own family, of this company, do you not?

A. I don't control my brother.

1315 Q. Well, you and your brother, through your families have the controlling stock interest in the company, do you not?

A. We have a majority of the stock, yes, sir.

1316 Q. Now, your company has advertised itself throughout the years as being the largest manufacturer of welding equipment, has it not?

A. Yes, sir.

Q. Did you not bring out Lincolnweld for the purpose of meeting the competition of Unionmelt?

A. We did not; no.

Q. Well, now, Unionmelt was first introduced commercially in 1938, was it not?

1317 A. I don't know.

Q. Well, what is your best recollection?

A. I would say that that is approximately correct.

Q. When did you first bring out Lincolnweld commercially?

A. My remembrance is, 1942.

Q. Did you not try, in the interval between 1938 and 1942, to get a license under the Jones patent?

A. We did not, no, sir—as such.

Q. Your answer is that you did not try to get a license under the Jones patent; is that correct?

A. Not as such no.

Q. Did you not submit a proposed form of license agreement, over your signature, to the Linde Company—

A. Yes.

Q. —asking for a license under the Jones patent?

A. No, sir.

1318 Mr. Cahill: May these documents be marked for identification, please.

(Whereupon the said documents were marked Plaintiff's Exhibits 219 and 220 respectively, for identification.)

By Mr. Cahill:

Q. I show you Plaintiff's Exhibits 219 and 220 respectively marked for identification, and I will ask you to state whether or not they refresh your recollection, that you sought to get a license under the Jones patent?

A. We did not seek to get a license under the Jones patent, no, sir. What we attempted to do—

Mr. Cahill: No. Just answer the question, please.

By Mr. Cahill:

1319 Q. Does that refresh your recollection—

A. We did not seek a license under the Jones patent, no, sir.

Mr. Cahill: I offer Plaintiff's Exhibits 219 and 220 for identification, in evidence.

Mr. Oberlin: No objection.

The Court: Admitted.

(Whereupon the said documents marked PLAINTIFF'S EXHIBITS 219 and 220 respectively were admitted in evidence.)

Q. Now, do you have a copy of this Lincolnweld catalogue?

A. Not in my pocket.

1320 Q. This Exhibit No. 203 is the Lincolnweld catalogue, is it not?

A. Yes.

1321 Q. Now, the Lincolnweld process that you introduced commercially in 1942 is described in this catalogue, Exhibit 203, is it not?

A. A large number of facts about it are in there, yes.

Q. Now, the statements made in this exhibit 203, the

catalogue, describing Lincolnweld, are true and correct, are they not?

A. They are true and correct in so far as publicity is concerned, yes. They may not be technically correct.

Q. Do you recall being asked this question, on your deposition—

Mr. Oberlin: What page?

Mr. Cahill: Page 44.

By Mr. Cahill:

Q. (Reading):

"Q. And you would say that the entire catalogue is correct?

"A. I would say so. We never misled our customers."

Now, did you make that answer on your deposition?

A. Undoubtedly.

1322 Q. Now, I put you the question, are the statements contained in this exhibit, Plaintiff's Exhibit 203, the Lincolnweld catalogue, true and correct?

A. They are correct within the limits of information you give to people who are not technically acquainted with matters of that kind, yes.

Q. Turning to page 1 of the catalogue, are you aware that the catalogue states—and I quote:

"Flux adjacent to the arc melts, floats on the surface of the molten metal, then solidifies as a slag on top of the weld."

A. Oh, very well.

Q. Well, did you know it was stated in this catalogue—and I quote:

"Since the arc and molten metal are blanketed by flux at all time, the weld metal is completely protected from contact with the air, assuring maximum quality of welds and making possible the use of extremely high amperage, for faster welding and lower costs."

Did you know that?

1323 A. Yes, I knew that.

Q. Are you aware this catalogue still further states—and I quote:

"Moreover, because the 'Lincolnweld' arc is confined within the blanket of flux, spatter is nil, thereby eliminating the expense of weld cleaning."

Did you know that?

A. The last two or three words were what?

Q. "—thereby eliminating the expense of weld cleaning."

Did you know that was in there?

A. I know it is true.

Q. Just answer my question. Did you know it was in there?

A. I didn't commit it to memory, no.

Q. Finally, did you know this was in there:

"Since the operation is devoid of arc rays and smoke, working conditions are improved."

Did you know that was in there?

A. I know that to be true. Again I hadn't committed it to memory.

Q. Turning to page 4 of the catalogue, do you agree
1324 with this statement—and I quote it:

"Absence of smoke, fumes, radiated heat, spatter and visible arc eliminates the discomforts of conventional open arc welding and results in an increased operating factor for lower welding costs."

Do you agree with that statement?

A. That is true.

Q. Now, this process I am reading about is the one your representative demonstrated or purported to demonstrate at the Graver plant in May, 1946, isn't that true?

A. So I understand; I wasn't there.

Q. You were in the court room—you said you weren't at the demonstration, but you were in the court room when the movies of that demonstration, being Plaintiff's Exhibits 87-A and B, were shown, is that correct?

A. That is true.

Q. And you saw the movies?

A. That is true.

Q. Tell us whether you regard the demonstration shown in these movies as living up to the statement:

"Absence of smoke, fumes, radiated heat, spatter
1325 and visible arc eliminates the discomforts of conventional open arc welding and results in an increased operating factor for lower welding costs."

A. Exactly.

Q. You regard that demonstration we saw as being representative of the truth of the statements I just read you from the catalogue?

A. The demonstration you are referring to is the one at the Graver plant?

Q. Yes.
A. Yes.

Q. Now, this Lincolnweld process that you put out was something new, so you claim, was it not?

A. What do you mean by "new"?

Q. I am asking you what you mean by it. You used it on the first page of the catalogue in big letters. See how big the word is there, "Lincolnweld"; it is in red ink, isn't it?

A. "The New Automatic Shielded Arc Welding Process"; that means it is new for us. It was a new process for us.

Q. Now, was this Lincolnweld process another milestone in industrial history?

1326 A. What is a milestone?

Q. I am asking you that. You used it here on page 2, in big headlines, in this catalogue, "Another milestone" in large type there?

A. "Another milestone"; undoubtedly the man that wrote that thought it was.

Q. I am asking what you think. Do you agree with that statement?

The Witness: I would not say it that way, no.

1327 Mr. Byron: Now you may explain.

The Witness: My idea of what a milestone might be would be somewhat different than that of the man who wrote this, perhaps; but there is very little doubt of this fact, that it did make possible welding of a great many things that were impossible of welding before, and did materially reduce the cost of many operations in automatic welding.

To that extent, if you want to call it a milestone, it was.

By Mr. Cahill:

Q. Now, in opening the case to the Court, your counsel state, at pages 91 and 92:

"What I mean to say is this, that Robinoff was the father, in using that step-by-step method, or process, and he used every single step that the Defendants use, and every single step that the Plaintiff uses."

Then skipping the next paragraph and continuing:

"So we have Robinoff at the top of my pencil here, and we have the Defendants coming off of this spur here, and

we have the Plaintiff coming off of this spur here,
1328 Robinoff being the father, and teaching the real process."

Now, do you agree with that statement?

A. Yes.

Q. Well, when did you decide for the first time that Robinoff was the father?

A. When I saw the operation in the National Tube Company.

Q. When did you take out a license under Robinoff?

A. When we started to use it.

Q. When was that?

A. I don't remember exactly, two or three years ago.

Mr. Cahill: I ask counsel to give us the date when the Lincoln Company took a license under Robinoff.

Mr. Stewart: We can give the date they started negotiations.

Mr. Cahill: No, I am not asking when they started negotiations. I am asking the date of the license, and I submit I am entitled to have an answer.

The Court: You can call on your adversary for that, if you wish.

Mr. Stewart: I don't have the date.

1329 Mr. Oberlin: We don't have it here. We can ascertain it from the parties, but at the moment I don't have it.

By Mr. Cahill:

Q. Now, it is a fact that you didn't take out the Robinoff license until the last couple of years, isn't that true?

A. That is true.

Q. What is your best recollection as to when you took out the Robinoff license?

A. I think we took it out in 1944. 1944 is my best recollection.

Q. Might it have been as late as 1945?

A. Pardon me?

Q. Might it have been as late as 1945?

A. It might have been as late as 1946.

Q. Yet you saw it, you testified on direct, for the first time in 1932.

A. We—

Q. Answer my question. Didn't you so testify?

A. Yes.

Q. And didn't you testify a moment ago that in 1932 you decided Robinoff was the Daddy, and now you say you took out the license in 1945, isn't that true?

1330 A. Your statement is correct.

Q. Didn't you testify, a few minutes ago you brought out Lincolnweld in 1942?

A. The first one.

Q. Well, didn't you testify you took out the Robinoff license as soon as you started using Robinoff?

A. I said in commercial quantities.

Q. Didn't you so testify?

A. In commercial quantities I did.

1331 Q. In other words, you took out a Robinoff license about two years before the patent expired?

A. (No answer.)

Q. Now, isn't it a fact that you hired Robinoff to work for you in connection with this case?

A. We hired him as a consultant.

Q. And when did you first hire Robinoff?

A. I have forgotten.

Q. What is your best recollection?

A. I would say, two or three years ago.

Q. In about 1942?

A. I think it was later than that?

Q. 1943?

A. I would say, 1943 or 1944, somewhere along in there.

Q. Would it refresh your recollection any if I told you that Robinoff says that you hired him in 1943?

A. Well, I would say that he was probably right.

Q. Now, is it not a fact that you decided to take out a license under Robinoff, only after you thought that Linde was going to sue you for infringement on the Jones patent?

A. That is not true.

Q. Well, did you not say in your note to Officers 1332 and Agents of your company, under date of April 6, 1945,—and I quote:

"The patent of Robinoff, mentioned above, was very much restricted, and was very largely a detail patent, because of the prior J. C. Lincoln patent"?

Did you not so state?

A. I did.

Mr. Cahill: That is all.

1333 *Redirect Examination by Mr. Oberlin.*

Q. Mr. Lincoln, did the letter dated October 8, 1941, which you wrote to Mr. Cornwell, and with which you enclosed a draft of cross-license agreement, form part of a more extensive correspondence between you and Mr. Cornwell?

A. Yes.

Q. In other words, letters both preceded and followed that particular letter, did they?

A. Yes, sir.

Mr. Oberlin: These remaining letters, may it please the Court, together with the one just identified, and already marked in evidence—or rather, I mean to say, excepting the one just identified, I offer in evidence as Defendants' exhibits.

Mr. Cahill: I would like to have your Honor reserve his ruling on them, until I have had a chance to read them.

Mr. Oberlin: The same being Exhibits 8, and 12 to 40 inclusive, as identified during the taking of Mr. Lincoln's deposition.

We will have to dig those out of the deposition file,
1334 and have them marked later. Counsel can reserve his objection.

Mr. Cahill: Yes.

The Court: The ruling is reserved on the admission.

Mr. Oberlin: That is all.

(Whereupon the said documents were marked Defendants' Exhibits 104-A, et seq.)

Mr. Cahill: Nothing further.

(Witness excused.)

Mr. Stewart: The defendants will call Mr. Boris S. Robinoff.

BORIS S. ROBINOFF, called as a witness on behalf of the defendants, having been duly sworn, testified as follows:

Direct Examination by Mr. Stewart.

Q. Will you please state your name and address.

A. Boris S. Robinoff, 5441 Fair Oaks Street, Pittsburgh, Pennsylvania.

Q. How old are you?

A. 67.

1335 Q. Where were you born, Mr. Robinoff, and where did you receive your education?

A. I was born in Russia, and I went through a classical high school there.

I left Russia in 1902, and went to Germany, and was educated in the Kaiser Wilhelm II Technological Institute, at Aachen.

1336 Q. What type of education did you have in Germany, in what field?

A. I received a degree of mechanical engineer.

Q. You are a naturalized citizen of this country?

A. I am.

Q. What was your first job after you left the University?

A. My first job was in Dortmund, Westphalia, in a condenser business concern, which concern practiced—at that time, it was about in 1967—acetylene welding to a certain degree.

Q. You said "1967".

A. 1907.

Q. 1907?

A. Yes, about.

Q. Acetylene welding?

A. Acetylene welding.

Q. Where did you first learn about the so-called hammer weld process?

A. My next job was again in Germany, in upper Silesia, where a concern by the name of Ferrum practiced the hammer welding of steel vessels in Kattowitz, which is in upper Silesia.

Q. The hammer weld process—

1337 Q. Mr. Robinoff, the hammer weld process which you learned about at that time—was it practiced in this country?

A. No, it was not.

Q. Did you have anything to do with bringing it to this country?

A. I introduced this process in 1912 when I came first to this country, joining the M. W. Kellogg Company in New Jersey, Jersey City, New Jersey.

Q. Mr. Robinoff, just to refresh your recollection, your first job was not with Kellogg, was it, when you first came here?

A. My first job was with the Pelton Water Wheel, where I got a jol as a draftsman. I stayed there two weeks, left them and went to M. W. Kellogg.

1338 Q. At the M. W. Kellogg Company, was that where you first introduced the hammer weld process in this company?

A. That is correct. In 1912 I was with M. W. Kellogg. I guided them in the design and operating of this new venture. I purchased machinery in Germany. I went back again for that purpose.

I designed, installed and helped to operate, not having any particular titles.

Q. How long were you with Kellogg?

A. I was with Kellogg from 1912 up until 1916.

Q. After that where were you employed?

A. I knew that the National Tube Company was interested in this process. I knew that they travelled in Germany and inquired about it, and I wrote to them a letter asking them if my services will be of any value to them, and they accepted me, in 1916.

Q. In 1916?

A. Yes.

Q. And you were with the National Tube Company, I believe, until 1943?

A. 1943, March, from 1916.

Q. Have you ever testified in a case before?

A. No, never.

1339 Q. You had your deposition taken, however, in this case, did you not, on August 13th?

A. That is correct.

Q. 1946?

A. That is correct.

Q. At that time how long did that deposition last?

A. About the whole day, until, if I remember it correctly, eight o'clock in the evening.

Q. Now what was your employment with the National Tube Company in connection with this hammer weld process?

A. They were interested in introducing this new type of welding, particula ly for the pipe, whereby Kellogg was interested only in ch mical vessels and the like. While I was with the Nationa Tube Company, since 1916, the Blaw-Knox Company appr ached Mr. Farrell, the president of the corporation, and as ted his permission to employ me as a consultant, installing again the hammer weld process for vessels, not pipe.

Q. Now, in 1924 or 1925, along in there, what happened in the pipe making industry that was of interest?

A. In about 1924 the A. O. Smith Company of Milwaukee started to weld large vessels which were called
1340 oil stills, ten feet in diameter, by means of electric welding, using coated rods.

We, in the hammer weld, at the National Tube Company, besides making pipe were making some oil stills ten feet in diameter, inch wall, and A. O. Smith was to a certain degree a competitor of this particular department I was connected with.

Q. In that connection did the National Tube Company to your knowledge purchase an authentic electric welding head?

A. In view of the fact that A. O. Smith entered into the electric welding field and was a competitor to us, I asked for an appropriation to buy an electric welding machine from General Electric for using bare rod, because we knew nothing about the coated rod, to get experience and to find out what is electric welding.

1341 Q. Were there any coated rods, that you knew of, on the market at that time?

A. There was only one, and that was the Quasi-Arc, that was made in England; and we tried it.

Q. Now, following the entry of A. O. Smith into the field of electrically welding these stills, did they go into the field of electrically welding pipe?

A. Yes, sir.

Q. Tell us about that.

A. Little by little, finding that they could make good stills by means of coated rods, I believe in 1926 we heard that A. O. Smith intended to invade the field of pipe making, and that, of course, threatened not only my little department, but it threatened the entire pipe industry; it threatened the National Tube Company, the Republic Steel Company, the Youngstown Sheet and Tube Company, and the whole family of pipe makers.

Q. Your position at that time was superintendent of the Hammerweld mill, was it not?

A. Yes, sir, that is correct. I was appointed superintendent in 1920, in charge of conducting the operating end of Hammerweld.

Q. And what were you asked to do by the National
1342 Tube Company following the entry of A. O. Smith into the pipe making field?

A. I was instructed to know everything that was going

on, and the only way for me to do that, was to follow their product into the field.

For instance, they would make a certain pipe line, say, 500 miles, and send it out into the field, and I would be there. I examined every inch of that pipe—or rather, I would not say exactly, every inch of it, but I made it a point to know how they made this electrically welded pipe; I examined it inside and outside; and I talked to the men who were in the field, and got information with respect to how that business was working.

Q. Now, those sections of pipe that were taken out into the field, and installed in pipe line: were they welded longitudinally in the plant of A. O. Smith, or were they welded in the field?

A. Longitudinally—or rather, I will put it this way: The pipe was welded longitudinally at the A. O. Smith plant.

Q. And then how were the circumferential welds made in the field, where the two sections were joined together?

1343 A. The two sections were joined together in a roundabout seam, either by way of acetylene welding or by means of a bare rod, or coated rod.

Q. Now, did anything unusual occur in Shreveport, Louisiana, as a part of your investigatory trip?

A. The Magnolia Petroleum Company asked the National Tube Company that I be sent to Shreveport to watch the performance of welding the A. O. Smith pipe, especially because, for the first time, A. O. Smith entered into the field of welding circumferential seams by their own heavy coated electrodes.

Q. What did you observe in Shreveport at that time?

A. For the first time I saw the meters work, the meter showing voltages, which is pressure, and amperage, which is the amount used, or something, whatever it is, heavier than I have ever known to be done.

Q. By that you mean a higher current and higher voltage?

A. Higher current and higher voltage. And the most surprising thing to me was that I saw chunks of coating falling down—

Q. You mean rod coating?

A. Yes, rod coating falling down in a groove,

and apparently not doing any damage to the weld,
1344 because when the slag was removed the weld to all appearances was sound.

Q. Following that and the rest of your trip of investigation, what did you do back at National Tube in the way of experimentation?

A. We came back, and we started to make our own coated rods. I read many a patent of previous days as to how the coating was applied, and we tried to make the same thing. We were unsuccessful.

Q. You tried—

A. Then a thought—

Q. Excuse me; you are not finished. Go right ahead.

A. Then a thought occurred to us—

Mr. Cahill: Your Honor, may we have the "we" defined?

The Witness: I mean the National Tube Company men. I had my assistant.

By Mr. Stewart:

Q. Who was that?

A. Mr. S. E. Paine.

Q. He is one of the co-patentees of the patent we are discussing?

A. Yes. And there was a Mr. Quillen, and the rest
1345 of the men.

And when I say "us", I am, in a subconscious way, referring to the whole crew.

Q. Continue, Mr. Robinoff.

A. We then started to work. The coating I scraped from A. O. Smith's rods and placed them in a plate, and see what happened when they go through with the bare rod. It was not satisfactory.

Q. Did anything unusual happen in that course of experimentation where you used various types of flux?

A. Yes. One day one of our welders welded two plates, with a groove in between them, with the bare rod on top of it.

Q. That was hand welded?

A. Hand welded.

Q. Yes?

A. Placed the plates on the ground. Our hammer welding department had a clay floor. The appearance of the weld on top with the bare rod looked normal; but when he turned the plate upside down, I observed the most un-

usual thing: the weld underneath was like a brand new silver dollar in appearance, but a long streak of silvery line.

Q. You mean the weld was shiny?

1346 A. Shining, extremely so. We sent the floor, as we found in our hammer welding—

Q. You mean a sample of the floor?

A. A sample of the floor, to our chemist and metallurgical engineer located at a different plant. We had no facilities to do any investigations of this nature.

Q. In your plant did you have a chemist?

A. No.

Q. You were the superintendent. Did you have any electrical engineer there outside of yourself?

A. We had electrical. We didn't have any laboratories, metallurgical engineer or chemical engineer; we were purely operating a day-to-day department.

Q. So if you wanted a chemical analysis of something made, you would have to send it to some other part of the steel corporation or National Tube?

A. That is correct.

Q. I hand you what has previously been marked Plaintiff's Exhibit 78, which you supplied plaintiff at the time your deposition was taken, a letter, and ask you to identify it.

A. It is a letter written by Mr. Hopke, a chemist, chief chemist of the National works, explaining to me,

1347 or rather trying to explain, what happened with the underside of the weld.

Q. Will you read that letter, please?

A. The whole letter?

Q. First may I ask—

Mr. Cahill: May I interrupt; I was getting the exhibit.

Mr. Stewart: I am sorry. First I would like to have it identified, and give it a number. This will be Defendants' Exhibit 105.

(Whereupon said document was marked Defendants' Exhibit 105 for identification.)

By Mr. Stewart:

Q. You have the original of which this is a photostat, do you not?

A. Yes.

Q. In your bag with you?

A. That is correct. I wouldn't say the original, because

in those I have are copies kept for my own guidance and file.

Q. Some of them are carbon copies?

A. Yes.

1348 Q. How long have you had them?

A. Oh, since the day when I received them. For instance, this particular letter, I have it since the date I received it. What was the date?

Q. October 13, 1926.

A. Since that time.

Q. Now, I ask you to read it.

Mr. Cahill: Just a minute, if the Court please. Is this to be read into evidence? If so, I object to it.

Mr. Stewart: It is.

Mr. Cahill: Then I object to it. This is apparently a letter from some third person to this witness, and it is hearsay.

Mr. Stewart: It is the analysis that you gentlemen asked for, of his own company, in the normal course of business, relating to acts of which he has personal knowledge.

1349 The Court: Well, if it is that, is not what you are trying to do to get the testimony of another person who is not here available for cross-examination?

Mr. Stewart: He was a chemist, and I believe it has been sufficiently identified as a true copy of a normal record of the National Tube Company works.

The Court: But does it not fall within the category of an extraneous statement by a person who is not available for cross-examination.

Mr. Stewart: No more so than any other normal record of a company's business. It is not my understanding that you have to go back twenty years to prove records that verify and bring out this witness' recollection.

The Court: I do not know whether this falls within that scope of regular entries, regular business entries, or not.

Mr. Cahill: I would say not by the farthest stretch of the imagination, if your Honor please. This is merely an attempt to get in the veriest kind of hearsay testimony

1350 by a witness who is not here. It does not come remotely within the ruling of regular business entries on a company's books.

The Court: Unless this document comes within that rule of permitting regular business entries to be intro-

duced without the maker being present, I am going to sustain the objection.

By Mr. Stewart:

Q. Mr. Robinoff, that photostat which you have was taken from a copy of a letter which you received in 1926 through the regular course of your employment with National Tube, was it not?

Mr. Cahill: I object—

The Witness: That is correct.

Mr. Cahill: I object to the form of the question—just a minute—in the light of the discussion and suggest that is both leading and suggestive, and is in effect testifying on the part of counsel, to put it into the question so that all the witness has to do is say "Yes"—

Mr. Stewart: Or "no".

Mr. Cahill: (Continuing) —that he received it in the regular course of business.

1351 The Court: It is preliminary. I am going to overrule the objection. Let the answer stand.

By Mr. Stewart:

Q. In the course of your position, holding your position as superintendent of the hammer weld plant, and later on of the Christie Park plant, did you have occasion to collect a file of papers for any particular purpose?

A. I did collect my own file, in view of the fact that the novelty of the method was very interesting to all parties of a large corporation, I got calls from all around, from New York and San Francisco, as to what it is all about, and I had my own file for guidance and quick answer of questions of this nature.

Mr. Cahill: If your Honor please, if we are going to pursue this further, may I call for the production of this file so I can see where this comes from?

Mr. Stewart: Yes.

(Handing file to Mr. Cahill.)

You have seen all this. These were part of the subpoenaed—

Mr. Cahill: I have not personally.

1352 Mr. Stewart: These were produced as a result of a subpoena served on Mr. Robinoff when you took his deposition.

Mr. Cahill: I have not personally seen this before. If your Honor please, I would like to have this document

marked for identification, with these scattered notes contained therein—I would like to have it given a mark.

I submit this is visible evidence that there are not entries kept in the regular course of business, just looking at the form of that thing.

Mr. Stewart: If the Court please—

The Court: It may be marked.

(Whereupon said document was marked Plaintiff's Exhibit 221 for identification.)

Mr. Stewart: If the Court please—

The Court: I will hear from you, Mr. Stewart.

Mr. Stewart: My objection to counsel's statement is this: Because Mr. Robinoff has a file that has some loose papers in it does not prove that the file was not a
1353 set of papers kept by Mr. Robinoff in the National Tube Company's business.

The Court: There is nothing before me now to rule on, as I understand the record.

Mr. Stewart: All right.

The Court: You may proceed with your next question.

By Mr. Stewart:

Q. Now, Mr. Robinoff, did you obtain a response to your request for a chemical analysis—

A. Yes.

Q. (Continuing) —of the clay floor of the hammer weld plant?

A. Yes.

1354 *By Mr. Stewart:*

Q. That is contained in a letter, a copy of which is in your file which Mr. Cahill is now examining; that is correct, is it not?

A. Yes.

Mr. Cahill: That I object to on the ground it contains an instrument not in evidence, it not being an instrument kept in the regular course of business, being, according to the testimony of this witness, for twenty years kept in what has been marked here Plaintiff's Exhibit 221 for identification, offering on its face real evidence of the fact that by no stretch of the imagination is it kept—

The Court: I have not heard from you yet on that. Objection overruled.

1356 By Mr. Stewart:

Q. What did you learn about the composition of the floor in the Hammerweld plant?

Mr. Cahill: I press the objection to that question, may it please the Court. This is an attempt now to circumvent the objection to the primary exhibit.

I mean, it is an attempt to get the testimony of an absent person, in here now, under the device of asking, "What did you learn?"

The Court: Is that not hearsay?

Mr. Stewart: It is no more hearsay, your Honor, than the testimony of any one of the witnesses whom the plaintiff has put on here, who said that they had analyses made, and so forth.

Here is a man who was operating this plant twenty
1357 years ago, twenty years before this lawsuit, and I am simply asking him what type of things he learned. He could not go and analyze a clay floor, certainly; he had to have it done; and I am asking him the question, as to what he learned.

Mr. Cahill: And I submit, your Honor—

The Court: The best evidence, of course, is the analysis. It is a question of whether or not the analysis is now admissible, in the absence of the chemist who made the analysis.

That is what it boils down to.

Now, it is Mr. Cahill's contention that this is not a document which was kept in the regular course of business.

Mr. Cahill: I do not think that the rule was ever intended to have application to such instruments as have been shown us in this form.

The Court: It does not have to be in a book, does it?

Mr. Cahill: No, your Honor, it does not have to be in a book; but we have had no testimony here as to the regular course of business of this company.

1358 The Court: "In any court of the United States, and in any court established by Act of Congress, any writing or record, whether in the form of an entry in a book or otherwise, made as a memorandum for recording any act, transaction, occurrence or event, shall be admissible as evidence of said act, transaction, occurrence or event, if it shall be made to appear that it was made in the regular course of any business, and that it was the regular course of such business to make such

memorandum or record at the time of such act, transaction, occurrence or event, or within a reasonable time thereafter.

"All other circumstances of the making of the writing or record, including lack of personal knowledge by the entrant, or maker, may be shown to affect its weight, but shall not affect its admissibility."

Mr. Cahill: If you were to take that as Mr. Stewart urges it upon you, your Honor, you would exclude absolutely nothing that was written on the letterhead of a company.

1359 I mean, that would be the only qualification that was necessary for the admissibility of a piece of paper in evidence.

Now, that rule had its genesis in a case that came up in Pennsylvania many years ago, where the question was whether bank entries would be allowed to go in.

The prosecution put its first witness on the stand and offered a transcript of the account, and counsel for the defendant objected on the ground that the man who made the particular entry was not personally on the stand, and the objection was sustained. That is how this rule got into the books.

Now, what Mr. Stewart is seeking to do is to go to the other extreme. Here is a paper that has not been for twenty years in the files of this company, but this man has had it since 1926, as I understand it, so that for some twenty years this entry alleged to have been made in the regular course of business, has allegedly been in the custody of this individual.

The Court: You mean to say, as I understand it, that if somebody from the National Tube Company was

1360 here, and said, "This is a part of our file, but I do not know who the chemist was; he is not here any more, not available", the objectionable aspect of this matter would be obviated; is that it?

Mr. Cahill: There is one that would be removed, your Honor, but as Wigmore says, when you have a witness on the stand who says that he has had this thing—and I do not use the word in any invidious sense—to all intents and purposes, secreted in his personal file for a period of twenty years, the paper lacks that circumstantial guarantee of trustworthiness which the sense of the rule requires.

If you had a witness here from the National Tube Company, who said that this had been kept in the regular course

of business, then I submit that your Honor would have to apply the test of whether it was the intent of this rule to allow such an analysis as we have here in this paper to be offered without our having an opportunity to cross-examine the chemist who made it, and the prejudice to us is great, arising, as you can see, from the fact
1361 that we do not have the opportunity to cross-examine that chemist.

Now, it does not avail to argue that, as between Lincoln and Linde, the chemical analysis as to their fluxes has been allowed in, because they are the parties to this action; they have control of the chemists in their employ. We have no control over what was happening twenty years ago, as to some man here whose name, even, we do not know, in respect to what is purportedly the copy of an original.

Mind you, may it please the Court, what is being offered to you here, now, is not a copy of a copy, but it appears, upon inspection to be a copy of an original. I take it that the original of this has been in this man's possession, and not in the company's files, for over twenty years.

Mr. Stewart: That has not been stated here.

Mr. Cahill: May I ask the witness that question, then?

1362 Mr. Stewart: Yes.

Mr. Cahill: To see if I can lay a foundation on that.

Mr. Stewart: First, however, may I be heard just briefly, your Honor?

The Court: Yes.

Mr. Stewart: Mr. Robinoff testified that he was superintendent of this plant. He has testified that he had no chemist in the plant, and in order to get a chemical analysis of something, in the normal course of his business, it was necessary to send to another part of the organization, a perfectly normal business method.

He has testified that this is a copy of the letter which came back.

He said that in his job, he had to answer questions all the time about this welding process that he had invented, so that he had to assemble a file, to help him in his job, in the normal course of his business; and that is what he presents here.

The Court: If you had a witness here from the National Tube Company, who brought here a file, a company

1363 file, out of which he took this particular letter, or record, that would presumably meet the test laid down here.

1364 But in the case of this witness, it was not his business to keep this file, as a part of the files of the National Tube Company. He kept it as his own personal file.

Now, does that not put it into a different category?

Mr. Stewart: He kept the original as a part of his business—the letters which he received, which were under his supervision.

The Court: But he is not testifying here as a witness for the National Tube Company.

Mr. Stewart: No.

The Court: As an employee of the National Tube Company.

Mr. Stewart: Oh, yes, he was an employee of the National Tube Company, your Honor.

The Court: He is not now.

Mr. Stewart: He has testified that he made the copies which he now has here. The objection goes to the weight of the evidence entirely. I think it is perfectly admissible.

Mr. Cahill: Now, may it please the Court, there is going to be a lot more—pardon me.

The Court: Is there any showing that this record,

1365 as a part of the National Tube Company records, is not available as such?

Mr. Stewart: We have not felt that that was necessary at all, your Honor. Counsel subpoenaed these records from Mr. Robinoff, and they took depositions.

The Court: Well, you may go forward and qualify its admission, but I am going to reserve my ruling on it for the present.

Mr. Stewart: I did not hear your Honor.

The Court: I say, you may go forward with whatever other qualification you desire, but I shall withhold my ruling on it, reserve my ruling at this time.

You may ask any further questions you desire, and you, Mr. Cahill, may ask the witness any preliminary questions that you may wish to ask.

Mr. Cahill: May I ask the witness just one preliminary question at this point, your Honor?

The Court: Yes.

Mr. Cahill: And this is not cross-examining the witness, at all.

1366 The Court: You may ask your preliminary question.

By Mr. Cahill:

Q. Referring specifically, Mr. Robinoff, to this letter dated October 13, 1926, Defendants' Exhibit 105: That is a photostatic copy of the original, is it not?

A. That is correct.

Q. Where is the original?

A. Here it is. These are the only two originals I have.

Q. It is in your file?

A. In my file.

Q. How long has it been in your file, which I believe has been marked for identification as Plaintiff's Exhibit No. 221.

A. I have two originals—

Q. No. Just answer the question, please.

A. The rest are copies.

Q. How long has this paper been in your file?

A. About twenty years.

Q. For twenty years the original of that has been in your personal file, which has been marked here for identification; is that right?

1367 A. That is correct.

Mr. Cahill: That is all.

The Witness: It was addressed to me.

The Court: You may ask him any further questions you desire, counsel, on this particular subject matter.

By Mr. Stewart:

Q. Mr. Robinoff, what did you learn, as superintendent of the hammer weld mill, of the composition of the floor after inquiry of the National Tube Company's chemist?

Mr. Cahill: Objection.

The Court: Sustained.

By Mr. Stewart:

Q. Did you obtain only one answer to your inquiry about the chemical composition of the floor, or did you get two, do you remember?

A. I don't understand the question.

Q. You got a letter from Mr. Hopke. Did you get any other letters?

A. By Mr. Goodspeed.

Q. And who was he?

A. Metallurgical engineer.

Q. In making the hammer weld pipe in that plant, what kind of a floor was it?

1368 The Court: Just a minute, please.

(Short interruption.)

By Mr. Stewart:

Q. In making pipe in the hammer weld plant with the hammer weld process, what kind of a floor was there in the plant?

A. It was a clay floor where we placed our hammer welded pipe to cool down before processing it further, and therefore the floor consisted of clay, and scale admixed with clay. It consisted of clay and scale.

Q. And what is scale?

A. Scale is an iron supposedly oxidized.

Q. Now, did you, after receiving chemical analyses, make up any samples of flux from the floor and try them as a welding proposition?

A. We continued to dig our floor all around, because it looked so attractive as a flux, and we used this clay-scale combination, placing it on top of the plates, and go through with the bare rod and welding it, experimenting continually.

Q. And did you do that with a hand welder, or did you use an automatic?

A. We used both. After the hand welding wasn't satisfactory, then we used an automatic welding machine
1369 purchased from General Electric, and we got some very good results from using this particular mixture of clay and scale as a protective blanket on top of the metal.

Q. And after receiving your chemical analysis of the clay, did you endeavor to find clay of the same chemical analysis outside to make flux with?

A. Yes. The clay which we used in the mill was dug from a nearby hill, and so we went outside and got the clay from the hill and mixed ours in proportions as our chemists and metallurgical engineer found it, so as to repeat the appearance or constituency of the flux as close as we could do it.

Q. And in your experimental work of making welds with the automatic head and piling the flux along the seam, were there occasions when there appeared to be no welding action?

A. Yes.

Q. Will you describe that?

A. We discovered time and again that, with the clay-scale combination, the arc wasn't visible. It was a startling discovery for us.

The Court: The what wasn't visible?

1370 The Witness: The arc wasn't visible to the naked eye.

We looked at the ammeter; we looked at the volt meter. They registered, and so apparently something was going on underneath. Then the arc will pop out—"Pop" is that correct English?

Mr. Stewart: That is good enough.

The Witness: Then it would disappear again, and so it went on.

Our man in the mill called it the submarine arc. That was the name we used, "submarine". Here we see it, here you don't. On top of the water you see it, underneath the water you don't; submarine arc.

By Mr. Stewart:

Q. And that is the name it was known by?

A. That was known, among our men, as submarine arc.

Q. Now, Mr. Robinoff, in connection with your trials and experiments in making welds using the General
1371 Electric automatic head and the clay and scale flux, what types and thicknesses of welds did you make?

A. We experimented mostly with wall thicknesses that we knew are going to be used, if at all, in the future in our pipe lines, meaning a quarter of an inch, five-sixteenths, up to three-eighths of an inch and sometimes a half an inch.

That was the extent of the orders.

Q. That was the extent of your experimentation?

A. That was the extent of it.

Q. Do you have with you a sample weld made in the National Tube Works prior to 1930 using the process of the General Electric automatic head and a pile of flux consisting of clay and scale?

A. Yes, I do. I have two samples, and if I may observe—

Mr. Stewart: First may we have them identified and given numbers?

(Whereupon said sample welds were marked Defendants' Exhibits 106 and 107 for identification.)

By Mr. Stewart:

Q. I hand you, Mr. Robinoff, what has been marked Defendants' Exhibit 106 for identification. Will you explain what it is and show it to the Court?

1372 A. The weld looks extremely smooth—

The Court: What is it, first?

By Mr. Stewart:

Q. What is it?

A. It is a sample of weld made with the bare electrode descending from the reel through a flux consisting of clay and scale. Is that the question?

Mr. Stewart: That is right.

By Mr. Stewart:

Q. Will you describe the surface of that weld?

A. The surface is smooth, attractive in appearance, and we worked on this type of welding for about two years.

1373 Q. The other sample, I believe, is marked Defendants' Exhibit 107. Will you tell the Court what that is?

A. It is a weld made with the bare electrode going through a bed of flux, the so-called submarine arc.

Q. Now, Mr. Robinoff, did you prepare a description of what you believed was an improved method of electric arc-welding, to be submitted to your superiors in National Tube?

A. Yes, I did.

Q. Did you write a letter to Mr. George A. Ruff, manager.

A. I did.

Q. Do you have a copy of that letter which you wrote?

A. I have.

Q. And will you read that?

Mr. Cahill: That I object to as a self-serving declaration. In this case we have the writer here.

Mr. Stewart: That is right.

Mr. Cahill: We are not limited to relying on something he reads to us. He can tell us himself. I object to it as a mere self-serving declaration.

1374 Mr. Stewart: This was a letter prepared and an entry made in the normal course of National Tube Company's business, and made by this man, and he is identifying it. I don't see how there can be any question.

Mr. Cahill: We don't have to rely on it. We have the primary person here; we have the witness himself.

The Court: What are you trying to establish, that he did something, or something happened at that time? Can't he tell the whole thing now as he told it then?

Mr. Stewart: I believe he can.

The Court: I believe I will sustain the objection, then.

By Mr. Stewart:

Q. All right, then, Mr. Robinoff, will you tell us what you wrote in a letter to Mr. Reuff in connection with a description.

Mr. Cahill: I object to it, because it is not material, what he wrote.

The Court: I don't understand what you are trying to establish, the fact that he wrote something or the fact something happened at that time. If it is the latter, then
1375 the question is objectionable and I am going to sustain it.

Mr. Stewart: I am asking him whether he wrote the letter and whether he has a copy of the letter he wrote at that time, and the contents of that letter, which is better in detail than his recollection. He has a perfect recollection of it, there is no question about that.

The Court: The question is not what he wrote then. It is what he now recollects that he observed then. Isn't that what you are trying to get out of this witness?

Mr. Stewart: I am trying to put in this record, your Honor, first the fact that this man wrote to his superior and enclosed therein a description of his invention, in October of 1927; and that description as he wrote it at that time, I think, is very material and quite admissible.

This is not something that anyone else wrote; this is the witness himself, the author of it.

Mr. Cahill: Such an instrument is a self-serving
1376 declaration. The committing of something to writing doesn't make it per se admissible evidence.

Mr. Stewart: It goes to its credibility.

Mr. Cahill: No, it goes to its admissibility. The fact that this witness wrote this to someone else is of no weight here. We have the witness on the stand.

The Court: Let's take an example outside of this litigation. If you see an accident, and you write the insurance company or write someone the next day, how the accident happened, it may be an admission against interest, but it

can't be used as a document to establish that witness's testimony as such; and that is what you are trying to establish here, is a document he wrote twenty years ago.

Mr. Byron: May I say just a word. This man had a conception, and cooperated with two other fellows on this conception. That was hidden in their minds.

He is explaining that conception to an officer of the company so an investigation with reference to that conception may be made to determine whether or not 1377 they are going ahead and file a patent application.

That is not watching an accident at all; it is something conceived right here, and he is expressing it.

The Court: It doesn't make it any more admissible because the subject-matter is different than in the example I gave.

Mr. Byron: What would be more accurate, something he wrote, twenty years ago at the time of the conception in his mind, or to have him give now his recollection of that conception?

The Court: It seems to me that is a matter of evidence.

Mr. Byron: It is a laboratory record he has, and that is conducted in the regular course of business.

The Court: If there is any rule of evidence that makes that admissible, I will hear you; but as I understand the rules of evidence, that is purely a self-serving document and, as such, is not admissible.

If you have some rule of evidence that permits it, 1378 I will hear you further on it.

Mr. Stewart: Your Honor, my only statement on that is, I believe you read the Federal rule on the subject of a record made—not kept for years, but made in the regular course of normal business.

This man made this record himself, and I think it is admissible on that ground alone.

Mr. Cahill: Your Honor, I have never heard—

The Court: If you can show that these documents are a part of the National Tube Company records, that is one thing. So far they appear to be his record that he kept and retained.

Mr. Cahill: Judge, even if we were to make that assumption, that these are records of National Tube, I have yet to understand that they would not come within the application of the rule of self-serving documents.

You don't make evidence admissible merely by putting it on a paper and putting it in the file, not when you have the witness on the stand.

1379 If we did not have the witness, there might be some point to argue here; but we have the primary person available, and he can give his recollection. We are not limited to something he wrote. The fact he writes it doesn't make it admissible; under the rules it is still a self-serving declaration.

1380 The Court: Does not this entry in the regular course of business have to do with events which happened in the regular course of business, such as making a deposit in a Bank? That is an event which is recorded. Now then, transposing that here, how can you do that?

Mr. Stewart: This is also an event recorded in the National Tube's records.

The Court: His impressions of what he saw?

Mr. Stewart: No, sir.

The Court: If he did something, if he made an experiment or did something there in the National Tube Company plant on a particular day, that might be an event; but what he saw there is not something that the National Tube Company did in its regular course of business.

Mr. Stewart: I believe it is, your Honor, in this sense, that here is an employee who is sending his description to the company, his superiors, to be reviewed to see whether they will take a patent out.

The Court: If he did an experiment and he made
1381 a record of it, that he made such-and-such an experiment on that day, that would be an event; but when you go further, and he says what he saw there that day, that is just a record of self-serving declarations which he put down and gave somebody.

I think there is a little different aspect to this thing, but I am going to reserve my ruling on this. I want to at least think it out and I want to read the record after it has been written up to further consider both of counsel's statements in regard to this admissibility.

Mr. Byron: May I just add one thing, which I think will offer some light on it. I will just take a very short time.

The Court: Very well, Mr. Byron.

Mr. Byron: In connection with the establishment of a record of an invention, let us assume that there are two men who claim the invention. They both have applications

in the Patent Office claiming the same allowable subject matter.

Under those circumstances what is called an Interference is declared by the Patent Office, for one purpose
1382 and one purpose only: That is to determine the question of priority of invention.

Priority of invention then is established by taking evidence. Of what? These dates: the date of conception, the date of disclosure to others, the date of reduction to practice, the extent of use, and so forth.

The best evidence of conception is a written description of that invention. That is exactly what Mr. Robinoff has here in this letter, a description of that invention, conveying that information to somebody else.

Now, in those proceedings to establish conception of invention before the Patent Office Tribunals and even before your own Tribunal, under Section 4915 that is admissible in evidence. In fact, you have to have that, or you have nothing. They will not take the man's word for it.

You have to have tangible evidence, and that is exactly what that is, a written description of the invention, dated.

Mr. Cahill: Judge, I will be even briefer. I will
1383 just read, with your permission, one sentence from Wigmore on Evidence, Volume 5, Third Edition, where Wigmore is speaking of entries in the regular course of business, and he is emphasizing the necessity, which I have earlier argued this proof lacked, of the second element; that is, circumstantial guarantee of trustworthiness.

But he says of the necessity principle, for the making of an exception, there must be some showing that the witness is unavailable.

Now, there has not been any showing in respect of this letter, that Mr. Robinoff is unavailable. He is here; and there is no showing in the case of the witness we tried to get in earlier, the chemist, that he is unavailable.

The Court: What have you to say in response to Mr. Byron's statement, that in Patent matters a question of date, which are at times important, or the establishment, that is, of patent dates, is best served by showing correspondence, or memoranda, that may have been kept or transferred back and forth between the inventor or
1384 alleged inventor, and those with whom he was working and that helps to establish dates which may or may not be important?

Mr. Cahill: I do not think, may it please the Court, that there is any different rule in a patent case than there is any other kind of a case. As I understand it, the rules of law are made for all cases, and I think the rule of law is a very salutary one, that a self-serving declaration is not admissible—period!

The Court: If this were in the Patent Office, would this type of evidence be admissible?

Mr. Byron: Yes.

Mr. Cahill: I do not know, your Honor. I am not a patent lawyer. Mr. Wolfe could speak with a great deal more authority as to that. But I say, we are in a Court of law, now, and operating under the rules of the Federal Court, and not the rules of any administrative procedure.

We are concerned now with adherence to the long established rules of evidence, than which there is none
1385 more firmly established than the one that we are debating at the present moment, namely, the rule against self-serving declarations.

It is novel to contend that, because you put something on a piece of paper, it can go into evidence, if you have the witness who wrote it, on the stand—

The Court: Is it being offered from the standpoint, and only from the standpoint of the date, and not as to its contents?

Mr. Cahill: No. I would not think, in any event, that it is admissible, unless you say that this regular-course-of-business rule has practically eliminated the rule against self-serving declarations, and I do not think that it has.

The Witness: May I ask a question there?

The Court: No, no.

Mr. Cahill: I think it is carrying it far beyond everything that I have ever heard of before. You might just as well say that all of the rules of evidence have been eliminated, if you allow self-serving declarations of this
1386 character to go in.

The witness is here. He can say what happened.

The Court: Well how would you establish, if it becomes important, that on such and such a date, certain things happened? He can testify that he saw certain things on such and such a date, can he not?

Mr. Cahill: Yes.

The Court: But to give it more verity, they are seeking to follow this method of proof.

Mr. Cahill: And that is the very thing that you cannot do. That is the very thing that the rule against self-serving declarations prohibits.

He is here, and he can say what he did, but he cannot buttress himself by saying, "I put it on paper", because the fact that he put it on paper does not add one particle of weight, in my opinion; and that is exactly what the rule is against.

There are many peculiar concepts that seem to come into these patent cases. For example, on cross-examination the other day, some witness was asked repeatedly if he
1387 would stake his professional reputation, or risk his professional reputation, or something.

The Court: Well, we have gotten past that one.

Mr. Cahill: The idea seems to be that in a patent case, there is some peculiar standard which is different from that in other cases. That I do not understand to be the law. I understand the law to be the same in all cases, and in that connection, I understand that an oath is an oath, in the Federal Court.

I do not understand that there is one set of rules for accident cases, and another set of rules for patent cases. If there is, it is new to me. I have never seen it in the books. On the contrary, the rules are the same, in all cases.

Why should they be different?

The Court: Well, I have your viewpoint.

Mr. Cahill: Yes.

The Court: I do not know that it is conclusive; there may be other reasons, too. Did I understand you to say that Mr. Wolfe is prepared to deal with that phase
1388 of it?

Mr. Cahill: I said that Mr. Wolfe could speak more readily on patent procedure, than I could.

Mr. Wolfe: If your Honor please, there is not anything peculiar about Patent Office procedure. They proceed there under the same rules of evidence that this Court does.

The Court: Do I understand that in an Interference proceeding, this type of evidence would be admissible to verify dates? I believe that was counsel's statement.

Mr. Wolfe: As far as I am concerned, your Honor, that is an incorrect statement of the law.

Mr. Byron: Now, you know better than that.

Mr. Wolfe: In an Interference proceedings, there is first of all filed what is known as a preliminary statement, which

is a pleading, and in that pleading each inventor must state under oath the date of his first drawing, the date of his first written description of the invention, the date of his first disclosure to others, and so forth.

1389 But, as in the case of any pleading, that is not proof, nor does it ever have any weight in the proof.

The Court: Does he submit, then, his prior written description, or disclosure?

Mr. Byron: Exactly.

Mr. Wolfe: No, nothing is submitted with that statement.

Mr. Byron: Well, now—

Mr. Wolfe: (Continuing) As an exhibit.

Mr. Byron: Just a moment.

The Court: One at a time, gentlemen. I will give you an opportunity to be heard in response.

Mr. Wolfe: The statement is filed in this form:

"I am the inventor; on such and such a date I made the first drawing of the invention; on such and such a date I made the first written description of the invention" and so forth, and so on.

The purpose of the role requiring that sort of preliminary statement is to put a brake on the inducement to

1390 change dates, and carry back beyond the facts, under pressure of the opponent's case.

The Court: But in the administrative practice, are those statements, written by the proponent, submitted as evidence in his case?

Mr. Wolfe: No, your Honor, they are not. They form no part of his case, and they can only be used to impeach, if there is subsequently a variance.

1391 Then when it comes to the matter of taking testimony, a letter of the kind which we have here would be admissible only under the normal procedure that where you have the recipient of the letter as a witness, and he is called to corroborate the inventor as to the date the inventor made his invention, and can do so by testifying that he received the letter on or about the date it bears, and understood its contents, and that was a disclosure of the invention to him.

But there is no question of that kind involved here.

Mr. Byron: That is just not so.

The Court: Just a moment, please.

Mr. Byron: Pardon me. I thought that Mr. Wolfe had finished. I am sorry.

The Court: I do not know whether he is through of not.

Mr. Wolfe: No self-serving memorandum of whatever form, is admissible merely because it is a memorandum of the inventor.

Mr. Cahill: What is the urgent necessity under these circumstances for pressing such an offer of this, may
1392 I inquire, your Honor?

Mr. Stewart: I can answer that, your Honor.

Mr. Cahill: May I finish my statement first, please.

Mr. Stewart: Yes.

Mr. Cahill: We have here this Robinoff patent, pleaded as the prior art. We have the patent itself in evidence, in 1930. There is no question that the patent in point of time antedates the date of the issuance of the Jones patent.

So why go into such fulsome detail as to what happened in the years anterior to 1930?

We have got the Robinoff patent in evidence; it is pleaded as prior art. Why do we need to clutter the record with all of these matters of doubtful character? The fact that we have had this much colloquy with the court about them, proves that they are of doubtful character.

I see no urgent necessity for this.

Mr. Stewart: I should like to answer that if I may, your Honor.

1393 The Court: Yes.

Mr. Stewart: Apparently Mr. Cahilll has not been in a patent suit before. Not only is the Robinoff patent the prior art, but also the teachings of the Robinoff patent, and what was done commercially, whether within or outside of the patent; and that is what is being shown here; what this man recorded at that time, as a discovery, and what he did in his mill pursuant thereto.

The Court: Well, as I said, I am going to reserve my ruling on the matter. I will rule on it in the morning.

By Mr. Stewart:

Q. Mr. Robinoff, I believe that I had asked you whether you wrote to Mr. Reuff, the manager, and enclosed a description—

Mr. Cahill: I object to any characterization of what was enclosed. Let the exhibit itself be marked for identification.

Mr. Stewart: I am only reading from it.

The Court: Well, go ahead and finish your question.

By Mr. Stewart:

1394 Q. Did you enclose something, when you wrote to Mr. Reuff?

A. I did.

Q. What was it?

Mr. Cahill: That I object to.

A. A description.

The Court: Just a moment. Just characterize it. Do not tell me what was in the letter.

The Witness: A description.

Mr. Stewart: All right.

By Mr. Stewart:

Q. In the field of electric arc-welding, Mr.
1395 Robinoff, what did you discover in 1927? Just tell the Court in your own words.

A. We knew of the existence of bare rod welding as practiced at that time. We knew of the existence and observed it in the field; of the way a coated rod behaves, but at that time we did not know that anybody ever placed a flux on the object to be welded, to go through with the bare rod. That occurred to us as a novelty at that date.

Q. What were the various steps and acts that you did to perform a weld when you used a flux on the plate?

A. You are talking about clay and scale?

Q. Clay and scale flux, yes.

A. We used a reel which descended continually down through a flux. We found after we blew the flux off the metal in a groove, and next to the metal was a slag and on top of the slag was the original part of the flux. That was something novel.

Q. Was that an arc-welding process?

A. Yes, sir.

Q. What current did you use and what voltage?

A. In the experimental stage we had about 400 amperes, or 500, and 20 volts. I would not remember it correctly. That was about the setting of the current
1396 which we used in the experimental stage.

Q. Did you, in 1927, prepare a diagrammatic drawing?

A. That is correct.

Q. What did it look like?

A. I have the drawing in here which I prepared, showing on a paper as to what our method looks like.

Q. Will you describe it, please? Use the drawing, if you want to.

A. Here is a drawing. It is marked "H.W." which means Hammerweld. It was in the Hammerweld department. It was October 5, 1927, and we show on this drawing a metal electrode.

Next to it we show what we called at that time, "Metal dioxidizing and refining compound", and next to it we show the sketch No. 1, the left side.

Next to it we show how the metal is deposited in the groove under the protection of the compound and on top of it.

The rest of the drawings we also tried, but we were unsuccessful.

The Court: What was that?

The Witness: The rest of the sketches also we tried
1397 at different variations, different variations of sketch No. 1, but we abandoned them because what is shown on sketch No. 1, the two drawings, left and right, were successful and we adopted them.

By Mr. Stewart:

Q. Was that sketch included in or enclosed in your letter to Mr. Reuff?

Mr. Cahill: That I object to.

The Court: Overruled.

A. That is correct. This drawing was given to my superior, Mr. Reuff.

Mr. Stewart: I ask that it be marked as Defendants' Exhibit 108.

(Whereupon the said document was marked Defendants' Exhibit 108 for identification.)

Mr. Stewart: And I ask that the letter, which has not been offered, be marked as Defendants' Exhibit 109, and the two pages of enclosure as 110.

(Whereupon the said letter was marked Defendants' Exhibit 109 and the two pages of enclosure as Defendants' Exhibit 110 for identification.)

1398 By Mr. Stewart:

Q. Now, Mr. Robinoff, when did you do any commercial welding—and by "commercial" I don't mean, to begin with, for sale outside National Tube plant but for use by anyone outside of your own plant—with this process?

The Witness: The Carnegie National Gas Company was

a subsidiary, and what we experimented for a number of years was accepted by them, as a sister corporation, as a gas line, placed underground for observation purposes, to see if this method is a method that could be intro-
1399 duced to the outsider without having any trouble.

It was Carnegie National Gas Company; and I have an order stating what it was, an order from Carnegie.

Q. When was it, Mr. Robinoff, that you welded that plate?

A. In September, the 10th, 1929, Pittsburgh Order 9,705.

Q. And what size pipe was that?

A. 24 inches outside diameter, by $\frac{3}{8}$ inch thick, and about 20 feet random lengths, plain end pipe.

1400 Q. What type and how many new welding machines did you get, and at what time?

A. I would not remember the date, but I know that we built another machine ourselves similar to the General Electric, and placed six heads on this machine so that each head would weld its own section of pipe, to expedite the time of finishing a certain length. That was done in 1928.

Q. And what did you do to train personnel to operate these heads, to get ready for commercial production?

A. We got fellows out of high school, and educated them in the process of welding, first starting with the bare rod, then with the coated rod, and then placing the flux on top of the pipe so that they could see and learn
1401 the process and be aware if anything is wrong during the process of welding.

That was called the school.

Q. Now, Mr. Robinoff, did you make any change in your flux, in getting ready for commercial production?

A. Yes, we did.

Q. Will you tell us about that?

A. While experimenting with clay and scale flux, we found out that certain plates furnished by Carnegie-Illinois Steel Company behaved very good, and yet other plates, with the same electric head, the same man, the same flux, the same conditions, for some reason misbehaved.

Q. What did you do about changing your flux?

A. So to be able to enter production for outsiders,
1402 we decided that clay-scale is not adaptable at all for fast and quick work.

So as to meet different types of plates, where we get

them, we changed the flux. We eliminated the scale, left the clay, added to it lime, unslacked lime, and ferromanganese after a certain time of experimenting, and established that disregarding what kind of plates we get from Carnegie we were able to perform the welding operation on the product.

Q. Now, what was done by the National Tube Company to get ready for commercial production, using your process?

A. We, of course, asked for an appropriation, which was granted to us, and we designed and developed not only welding machines, but there were many other operations connected with the welding, like presses, finishing machines, and so on. This was all prepared, and I believe that is all.

Q. Well, what appropriation was made by National Tube? How big was it?

A. About two and a half million dollars.

Q. And what was that two and a half million dollars spent for?

A. It was spent to create as what we called a
1403 tonnage plant to produce pipe for gas lines or oil, from 14 inches in diameter up to 30 inches in diameter. That was one branch.

The other, to make an auxiliary of the hammer welding, to manufacture pipe from 24 inches in diameter to up to 60 inches in diameter, for city water lines and other purposes. There were two different and distinct departments.

1404 Q. Now, Mr. Robinoff, when you changed your flux from the clay and scale over to clay, lime and ferro manganese, what was the difference in them so far as their weight was concerned?

A. Oh, the scale and clay was by far heavier than clay, lime and 2 per cent ferro manganese.

Q. What were the proportions of the clay, lime and ferro manganese?

A. We measured it by volume. 98 per cent by volume of clay—

Q. 98 per cent?

A. 89 per cent of clay by volume. 9 per cent of lime by volume. 2 per cent of ferro manganese by volume.

Q. And what made the clay and scale so much heavier?

A. That is because you see, when mixed, the clay and scale is in a proportion of two parts by volume of clay and

1 part of scale by volume, so in three parts one-third was scale and scale is iron oxidized. I surmise that the iron made it so much heavier.

Q. Now Mr. Robinoff, what was the first commercial order for pipe welded by your process under deep flux in the Christie Park Plant of which you were in charge?

A. The first order was in July, 1930, from what at
1405 that time was called the Missouri-Kansas Line, 300 miles of 24 inch, outside diameter, 5/16ths wall.

Mr. Cahill: What is that last? 5/16ths what?

The Witness: 5/16th inch wall thickness.

Mr. Stewart: Wall thickness.

Mr. Cahill: 5/16ths?

The Witness: 5/16ths, yes.

By Mr. Stewart:

Q. What was the second order?

A. 77-1/4 miles from the same company, 22-inch, outside diameter, 5/16ths inch wall, 40 feet long, one piece, in both cases, in both instances.

Q. Those orders were filled, for welded pipe?

A. They were filled and supplied to the field.

Q. Have you had occasion to see a section or a piece of one of those sections of pipe which was welded in
1406 your fonnage mill or in the Christie Park plant in 1930?

A. I have.

Q. Where did you first see it?

A. At Mr. Bomberger's office on Monday evening when I came there, a section about three feet long and eight inches wide, with the weld on top of it. I examined it and outwardly I recognized it as a pipe made by the National Tube Company, 22 inches o.d., 5/16ths of an inch wall.

Mr. Stewart: Will you mark this as the next exhibit, please, for identification.

(Whereupon said article was marked Defendant's Exhibit No. 111 for identification.)

By Mr. Stewart:

Q. Is this the sample (indicating)?

A. That is correct.

Q. That you first saw in Mr. Bomberger's office?

A. On Monday last week.

Q. Did you make any further inquiry as to where this came from?

A. Yes. On Wednesday I left for Chicago. I contacted the main office of the Panhandle & Eastern Pipe Line
1407 Company, the successor of the Missouri-Kansas. There I got a letter of introduction to go to the field where this pipe was laid, to interrogate, and I interrogated the men who cut this section out.

I measured the lengths, and measured the widths of the opening so as to be sure that that is part of this pipe.

Q. That particular length of pipe—could you tell whether it had been recently cut?

A. They told me that—

Mr. Cahill: I object to what they told him.

The Court: Sustained.

Please read the question.

(Question read.)

By Mr. Stewart:

Q. Could you tell from looking at it?

A. I could.

Q. Was it?

A. It was.

Q. What kind of a section had been cut out besides this?

A. Apparently a complete section; of what lengths, I could not establish, of course. It was cut out from
1408 the end toward me, and I could not see, of course. It was gone. Someone got it.

1409 Mr. Stewart: I offer the exhibit in evidence, Defendants' Exhibit No. 111.

Mr. Cahill: May I ask a few questions?

The Court: You may.

1410 Mr. Cahill: Where did you get this piece of pipe, Mr. Robinoff?

The Witness: As I told you, the first time I saw it was in Mr. Bomberger's office.

Mr. Cahill: You never saw it before in your life, is that right?

The Witness: I could see it in the mill. I might have seen it.

Mr. Cahill: Just a minute. You said that the first time you saw it was in Mr. Bomberger's office, is that right?

The Witness: This particular piece.

Mr. Cahill: Yes. That is the first time you saw this particular piece?

The Witness: This particular piece.

Mr. Cahill: Is that right?
The Witness: Correct.
Mr. Cahill: So as I understand your testimony you have never seen this particular piece before, is that right?
The Witness: I would not say that.
Mr. Cahill: Well, now, maybe we are not understanding each other, but I take it from what you told me that the first time you saw this piece of pipe was the other
1411 day in Mr. Bomberger's office. Am I right or wrong?
The Witness: You are right in interpreting what I said, but may I add to it that this pipe was in the mill where I was in charge.
Mr. Cahill: I move to strike that out as not responsive to my question.
Mr. Byron: I submit, your Honor, it was.
Mr. Cahill: I asked him did he see this pipe.
The Court: Overruled.
Mr. Cahill: I beg your pardon?
The Court: I will let the answer stand. Proceed.
Mr. Cahill: You saw this piece of pipe only once, is that right, Mr. Robinoff?
The Witness: That is not true.
Mr. Byron: That question has been answered a couple of times.
Mr. Cahill: May I go back over it, if I am permitted?
The Court: Yes.
Mr. Cahill: You saw this piece of pipe—I am directing your attention now to this physical exhibit.
1412 The Witness: Yes.
Mr. Cahill: (Continuing) —just once in your life.
The Witness: I would not say that.
Mr. Cahill: Well, you do not know whether you ever saw it before, is that not true?
The Witness: I saw thousands of miles of pipe in the mill and that may be one that I did see.
Mr. Cahill: I am not asking what may be. I am asking you about this piece of pipe, Plaintiff's Exhibit 111—or rather, Defendants' Exhibit 111. Can you tell us that you do not know that you saw this piece of pipe before?
The Witness: I may have.
Mr. Cahill: Will you please answer my question? Can you tell us "Yes" or "No"?
Mr. Byron: I object.
Mr. Cahill: Can you tell us that you did see this piece of pipe before?

The Witness: No. I could not tell you that.

1413 Mr. Cahill: I object to its admissibility unless the witness can state that he saw this piece of pipe before. We are given here a piece of pipe some 20 years—

The Witness: There were 1,000 miles of pipe—

Mr. Cahill: Just a minute, please.

The Court: I understand your objection. Are you pressing its introduction, Mr. Stewart?

Mr. Stewart: Yes, your Honor.

The Court: He saw it, as I understand it, in Mr. Bomberger's office for the first time That is the only thing he can definitely say as to its identity. Unless there is some hook-up as to where it came from, is not this offer objectionable?

Mr. Stewart: He went to the owner of the pipe line, the place where it had been sent from and measured the place where it came from.

The Court: Strictly speaking does that hook it up? Is it not possible, at least, to have the same dimensions of a hole and have a different piece of pipe, and this not be the pipe which made the hole?

1414 Mr. Stewart: It is possible that is a matter of credibility of the witness.

Mr. Cahill: No. It is not a matter of the witness's credibility. It is a matter of the source of the pipe. All the witness can say is he saw it for the first time the other day.

The Court: It seems to me that unless you trace it and show that that is the pipe which made the hole, which was inserted before the hole was cut in that particular length of pipe, it is objectionable.

Mr. Stewart: May I put this question to the witness, your Honor:

By Mr. Stewart:

Q. Mr. Robinoff, will you examine that pipe and considering your knowledge of the pipe lines made in your Christie Park plant, can you say whether or not that was made under your supervision?

A. The pipe—

Mr. Cahill: I object to that. On the proof here that would be a guess of a speculative character.

The Court: I think so. Sustained. He said he did 1415 not know whether he saw that or not.

Mr. Byron: He did not understand the question.

By Mr. Stewart:

Q. Mr. Robinoff, in looking at that pipe can you describe any differences or any similarity between the pipe line that was made in your mill of that diameter and that thickness—

Mr. Cahill: To that I object as not—

By Mr. Stewart:

Q. (Continuing) —in 1930?

Mr. Cahill: Excuse me. That I object to as not being the test of the laws of evidence as to the establishment of identity, as to whether he can describe in appearance any resemblance or differences.

Mr. Stewart: We can use it as only illustrative, if he can testify about it.

The Court: If it is only illustrative there is no—

Mr. Cahill: No probative effect to it, then.

The Court: I will sustain the objection.

1417 BORIS S. ROBINOFF, called as a witness on behalf of the Defendants, having been previously duly sworn, resumed the stand and testified further as follows:

Direct Examination (Continued).

1418 Mr. Oberlin: May it please the Court, before we proceed, I desire to make a statement, and a request of the Court, that we may have a demonstration at the plant of the Graver Company tomorrow afternoon, if that is agreeable.

What will be done, will be this: We will illustrate welding with the regular Lincolnweld flux, under varying conditions, and we also expect to show welding under plain sand, silica sand.

We also expect to demonstrate welding with the coated weld rod, the regular production coated weld rod.

That can all be done, we believe, in a period of approximately half an hour, and because we have no laboratory available, but only the plant of the Graver Company, it is desirable to schedule this demonstration, if the Court so rules, for about three-thirty tomorrow afternoon. The plant has a change in shift at about that time, and it will be quiet

enough to make the necessary observations for about
1419 half an hour thereafter.

Therefore, if the Court is agreeable, I suggest that we recess from this place to the Graver plant tomorrow afternoon a little before three-thirty. That plant, I might say, is nearer than the Linde plant is, and it will take only about ten minutes to get there from here. We will arrange transportation facilities.

As I say, we should conclude the demonstrations in approximately half an hour, or perhaps just a little longer than that; and that might perhaps conclude the session for that day.

1428 Q. Mr. Robinoff, yesterday when we adjourned we were talking about the first commercial orders for welded pipe and you testified that they were for the Missouri-Kansas Pipeline, is that right?

A. That is correct.

Q. Now, will you describe to the Court the ton-
1429 nage mill in Christie Park where you were in commercial production beginning in 1930?

A. A pipe was placed on a carriage. The carriage moved forward. Having on top of the pipe a groove, V-shaped groove, it ecountered in its travel a little wheel which was pressed into the groove so as not to permit the pipe to shift from a certain direction.

Next, the pipe in its travel encountered a large boot filled with flux, with an opening below, next to the groove, so that the flux covered the groove plus a certain height above the groove.

Then, on its further travel, while the pipe moved, it encountered a bare electrode descending from a reel, pushed by mechanical means downward, at a certain predetermined speed, so as to fill the groove.

The next thing that the pipe encountered on its travel was a knurled wheel which broke up the slag, and this wheel was connected with an exhaust pipe, and flux, plus slag, plus whatever there was on it, was sucked away, so that the pipe was clean.

Then quickly it came back, was removed, and another piece of pipe was placed on it.

While we performed this operation, the flux in back
1430 of the weld—say that here (indicating) is the weld, and here (indicating) is the portion already welded.

Q. Indicating approximately how many inches, Mr. Robinoff?

A. Oh, I would say, approximately ten inches, or twelve inches, about—well, no; I would say, a distance of approximately fifteen inches.

Q. Continue.

A. The flux was still in a hot condition, I would say, molten, bubbling and moving like a wave; showing to us that the metal underneath was protected from the air by this molten flux, so that the cooling of the metal was gradual, which was in contradistinction to any previous types of welding bead, bare rod or coated rod.

In other words, the anhealing, as I might call it, prevented the rapid cooling of the metal which, as I understand it, is quite an advantage in welding.

Q. All right. Now, Mr. Robinoff, how many welding heads and jigs on which the pipe was moved, did you have in the tonnage mill?

A. We had thirty welding machines, each one independent of the others, with own generator, its own
1431 welding head, and its own boot; and the description of the mechanical performance that I gave you was a separate thing for each machine.

Q. Now, how was the flux fed into that boot? First, where did the flux come from, and second, what means were used to fill the boot?

A. Carloads of clay, which at that time we could not dig in the hill, but which we had to order from the outside, were coming to a separate building, which we called the pulverizing department.

This clay, which we called Kitanning No. 3, which apparently was the name of the vein of the clay, was dropped in a chute outside, and came into the pulverizing plant where a Raymond—of Chicago—pulverizing machine was grinding the clay, and heating the clay at the same time.

Q. Why did you heat the clay?

A. Because clay contains moisture, and we intended to dry the moisture out of the clay, and this was part and parcel of the performance of the pulverizer, to grind and heat at the same time.

Q. What happened to the clay after that?

A. This clay was then emptied on the other side of the pulverizing department; and I might say that
1432 the same performance that I have just described to you pertaining to the clay, was performed with lime, which we got from our National works, and ferro-manganese, separately.

All three ingredients were brought up by an elevator, on a platform, measured by volume as I described to you here yesterday, 89 caly, 9 lime, and 2 ferromanganese, and put into a tumbling barrel, so as to intermix them thoroughly for the purpose of using them in the machines.

We introduced later on a separate heating device, which was a little drum, heated, where we placed our mixture, the complete mixture, from the tumbling barrel, and heated it again, to the extent as it appeared to me, that it entered solid into the kiln, and came out, as it appeared to me, just visually, fluid-like, because it always moved in a pan.

1433 Q. By "fluid", Mr. Robinoff, you don't mean in a molten state, not melted?

A. No, it wasn't molten, sort of water-like. It seeks its own level in a pan, and from there it was placed in little buggies, carried along the corridor, or rather a platform along the thirty welding machines, and deposited in each boot to be used on the welding machines.

Q. And how was the quantity of flux that would come out of that boot onto the seam to be welded controlled?

A. We had a flapper valve which could be opened more or less, regulating the amount of flux which we wanted to place on top of the pipe and on top of the groove.

Q. Now, Mr. Robinoff, you also commercially welded, did you not, sections of pipe in a hammer weld mill, which was a separate building?

A. Yes. And the mechanics of the welding were somewhat different, but the idea was the same. The pipe diameter was up to 60, in diameter.

Q. 60 to 66 inches?

A. 60 inches. The pipe was stationary, clamped, it didn't move, but the electric welding head moved
1434 along the seam on top of the seam, descending a bare electrode and depositing the flux.

While I am talking about the different methods, or, rather, different mechanical equipment for the two departments, I want to state that in the tonnage mill while the pipe travelled forward, it encountered inside of the pipe a copper backing bar, over which the pipe did slide.

This copper backing bar was pressed up against the pipe and arranged in such a way on a pin so that it could adjust itself to the inside contour of the pipe, which is never the same; so that the deposited metal filled the groove

and encountered the backing up bar, and it made what is usually termed a good penetration underneath.

Besides that, with our flux, we found—I am talking only about our flux—we thought it was necessary to introduce a mechanical contraption whereby we could direct the blow of the arc where we wanted it to go.

Now, as it is usually known, the arc is comparatively a wild thing. You know, it goes right, left, forward, backward. We found out that with our flux we had to do
1435 something mechanically to force the arc backward; and when I say "backward" I assume the pipe moved this way (indicating), and the metal is deposited, and we always deposited the metal throwing it in back of you and not throwing it in front of you, so as to disorganize the whole performance.

To do that we introduced a current from a separate source, an electroplating generator of about 600 amperes and of about 4 volts, and with this current—and with this current superimposed upon the backing up bar, we were able to combat the magnetic disturbances which are usually present in welding in such a way that the welder could direct his arc wherever he wanted to by either letting the current run one way or the other way, from zero to
1436 600 one way and from zero to 600 the other way. That was an excellent means for us to do what we wanted to do.

By Mr. Stewart:

Q. What is that type of current, introduced in the manner in which you have described, called in welding?

A. We called it preventing disturbances, to avoid magnetic disturbances; to prevent disturbances.

Mr. Stewart: I will put my question another way, Mr. Robinoff.

By Mr. Stewart:

Q. That separate current that you introduced there came from a separate source to the back-up bar, is that correct?

1436½ A. That is correct.

Q. It did not enter into the actual welding operation and provide heat?

A. No.

Mr. Cahill: That I object to—

The Witness: Not at all.

Mr. Cahill: —as being leading and suggestive.

The Witness: Not at all.

The Court: Well, the question has been put and answered. Proceed.

By Mr. Stewart:

Q. What was its purpose? What was the purpose of using—

A. To make a better weld.

Q. Now, Mr. Robinoff, when you got into commercial production in the tonnage mill and in the hammer weld plant, what inspection was there of the finished welded pipe sections?

A. After the pipe in the tonnage mill reached what we call the finishing department, it went through a number of operations which we called finishing operations, and then it reached a testing machine.

This testing machine was a hydraulically operated
1437 machine. The pipe was placed between the two heads, rolled in, the two heads closed in and water was injected by a centrifugal pump, and then the pressure was applied and while the pipe was under pressure, on top of the pipe—the weld was always on top—each two feet there was a mechanically operated hammer, and it hammered extremely fast, pounding on the weld so that we would be sure that the weld would withstand hydrostatic pressure which usually was 50 per cent above the field pressure and very often higher.

Q. What requirements were there put on you so far as your sections passing tests is concerned? Did you impose them on yourselves, or where did they come from?

A. We usually submitted our own specifications, what we wanted to do, but the purchaser did not listen to our way of doing it. He introduced his own requirements.

These requirements were, besides the hydrostatic testing machine, testing the whole pipe as a unit—

Mr. Cahill: May we have this identified, as to whose requirements these were?

1438 Mr. Stewart: The purchaser's.

The Witness: The purchaser's.

Mr. Cahill: We would like to have the purchaser identified now, if we may, or we will have some unidentified person speaking.

The Witness: For instance, the Missouri-Kansas Line.

There were some others I do not remember. I know them, but—

By Mr. Stewart:

Q. Were there any outside inspectors?

A. Yes. The purchaser usually engaged an outside party to inspect the pipe.

Mr. Cahill: I object, your Honor, unless we are told who the party is.

The Witness: I will tell you.

Mr. Cahill: In each instance.

The Witness: I will tell you.

Mr. Cahill: Because it is impossible to cross examine if we are just told generally what people did.

The Witness: The Moody Engineering Company, in my opinion a very well known concern, was an outside party engaged usually by the purchaser to enter the mill, 1439 having freedom to do whatever they pleased.

R. W. Hunt is another engineering concern engaged by outside people. We in the mill and I as superintendent had no jurisdiction over them.

By Mr. Stewart:

Q. What other types of tests were made than the hydrostatic test of filling the pipe with water and increasing the pressure?

A. As the pipe was manufactured, either in the hammer weld, or the other welding machines, the inspector would pick out any pipe he wanted, cut samples, pull samples to see where the sample breaks, bend samples to see the amount of ductility, and perform what was called at that time a certain standard number of tests, besides that.

1440 These particular tests on samples were not indicative of what was actually happening to the pipe.

We often welded two heads on a pipe, and blew up the pipe, bursted the pipe, to see what happened to the whole pipe, as a unit, and not just little pieces.

Q. What type of bending test was done on a section of weld?

A. To make a bending test, the beads—or rather, the raised surface on top and bottom was shaved off; it was placed in a jig; and bended in a standard way.

Q. Can you illustrate the manner in which those tests were carried out, by these sample?

A. If there is a raised surface in here, on the top or on the bottom, if you begin to bend the sample, to find out as to what extent it will bend, it will never bend in the weld, due to the raised surface.

Therefore, to establish that, we shaved the bead off inside and outside, made two lines in here, measured these two lines at the beginning, and measured the distance of the two lines after it had been bent, and that gave
1441 us an idea as to the extent to which this weld was ductile.

Q. What about pull tests?

A. We often pulled it with the weld as-is, and then we prepared what we call regulation samples, under the rules and laws of the American Society of Mechanical Engineers, the American Welding Society, and the American Petroleum Institute.

This type of pull is just to see where we are going. It is not a regulation sample, and it usually does break outside of the weld, in the plate.

Q. What does that show about the tensile strength of the weld, even though the weld is larger in volume?

A. It shows in this case that if somebody begins to pull it, the plate will give before the weld.

Q. Then what other type of test was made?

A. We performed so-called, in technical language, nick and break tests.

Q. That is, n-i-c-k?

A. Yes, nick and break tests.

Now, here (indicating) is a weld, and we wanted to see what was inside of it, so we took a saw, and sawed on top a little bit, on this side a little bit, and sawed on the
1442 bottom; and that tear in the steel, just like the tear in a piece of cloth; and if you have a little bit of an opening, you can pull it very fast—I say, it gave us visual observation of what was inside.

That was called a nick and break. This (indicating) is the pull, and this (indicating) is the bending.

Then we often etched a sample to see the appearance again, visually, of the weld.

Q. When you refer to etching a sample, what do you mean, Mr. Robinoff?

A. You see, you take a saw, or a tool, and go through the steel. The tool tears the steel, and so there is a certain way of cleaning those tears, and penetrating sufficiently to see the appearance of the weld.

That is called etching, in my language.

Q. What is used for that, do you know?

A. Acids or—I wouldn't remember. All kinds of acids.

Mr. Stewart: Do you have any objection to our introducing those as illustrative of his testimony?

Mr. Cahill: I object to it if they are being used
1443 as anything other than pieces of metal. They are not identified as coming from any source.

I don't object to them being offered as pieces of metal; if anything more, I object.

1445 Mr. Cahill: I understand they are being offered as pieces of metal, and not illustrative of any weld done at Western Pipe.

Mr. Stewart: I hadn't asked him to identify them as to where they came from until Mr. Cahill customarily objected, then I asked him to identify them, which he did as coming out of this piece of plate.

Whether that piece of plate has been in the court room before makes no difference.

The Court: As I understand, you offer them as being representative but you are not offering them as identical welds.

Mr. Stewart: No.

The Court: Then they may be admitted.

(Whereupon the said articles were marked DEFENDANTS' EXHIBITS 112 to 115, respectively, and admitted in evidence.)

1446 By Mr. Stewart:

Q. Now, Mr. Robinoff, what has been marked as Defendants' Exhibit 112 is the U-shaped piece of metal which you described in connection with your bending test, is that right?

A. That is called free bend test.

Q. Free bend test. What has been marked Defendants' Exhibit 113 is a section of plate with the weld in the metal, before any planing has been done on either surface, or before it has been bent?

A. And etched; I believe so. Isn't that etched?

Q. Etched.

A. It is etched to see the appearance of the weld visually.

Q. The side surfaces, which you have cut through the weld, have been etched?

A. That is right.

Q. And what has been marked Defendants' Exhibit 114 are the two pieces illustrative of a pull test?

A. "As is", as we used it, not doing anything to it. "As is."

Q. As is. That is, that you have not planed down the raised surfaces of the weld?

A. As is.

1447 Q. And Defendants' Exhibit 115 is illustrative of what you call the nick and break test?

A. Nick and break.

Q. Mr. Robinoff, how many miles of pipe were welded by your process in the Christie Park tonnage mill and Hammerweld mill during the years 1930, 1931 and 1932?

A. About a thousand miles; about a hundred thousand tons.

Q. Worth how much money in orders?

A. Oh, I would say about eight million.

Q. And what has happened since then, to the best of your knowledge, to those pipe lines today?

A. To the best of my knowledge, this pipe is underground, and still performing today.

By Mr. Stewart:

Q. Now, Mr. Robinoff, when did you stop production of welded pipe in the tonnage mill?

A. We run 1930, 1931, stopped in 1932, 1933, 1934,
1448 and made only a few scattered orders in 1935, and then closed it altogether.

Q. What was the reason for closing the tonnage mill and stopping the production in that mill of electrically welded pipe?

A. As I explained previously, A. O. Smith entered the pipe game. We had no facilities to make a 24 inch diameter pipe.

Q. By "we" you mean National Tube?

A. I always call it that way.

Q. All right, proceed.

A. We had no facilities to make a 24-inch diameter pipe, except by the old method called lap welding. We couldn't compete with A. O. Smith with lap welding.

1449 While we started to building the electrical weld department, tonnage mill, at Christie Park, simultaneously we started to experiment to increase the ability of seamless mills. By "Seamless", I mean no welding. It is a

piece of pipe that there are no welds. It has walls without welds.

While they experimented and it wasn't so sure where they are going, we were then contractors—rather, I say we in Christie Park were the top notchers in producing this type of pipe.

But while the seamless developed and found out that they can make 24-inch diameter pipe, they took all the orders, and I sat there and looked upon the empty mill.

Q. Seamless pipe was being sold by National Tube?

A. National Tube.

Q. And at that time you were out of business in welded pipe, is that correct?

A. I was out of the business, and the seamless—as a matter of fact, National Tube Company didn't like the—

Mr. Cahill: I object to what National Tube Company liked or didn't like.

1450 The Court: Sustained.

By Mr. Stewart:

Q. All, right, Mr. Robinoff, during the period of operation—oh, just a moment. How long did production continue, whether it was sporadic or not, in the hammer welding plant?

A. Up until 1940, we made a number of city water lines, like Harrisburg, Pennsylvania, Grand Rapids, Michigan, Washington, D. C., New York, and many, many others, of large diameter, up until 1940.

Q. Has any other pipe been electrically welded by National Tube since then, to your knowledge?

A. No.

Q. Mr. Robinoff, did you have occasion to demonstrate samples of your welds or give any talks about your process in the early thirties? If so, where did you do it?

A. I was an operating man, and I was asked to go to all the conventions—American Petroleum Institute, American Gas Institute—in 1930 and 1931, while we were still in preparation, and show them what we can do in the way of welding.

I was not a salesman. They called me the prima
1451 donna salesman, coming from the operating department.

I carried with me a box of samples which were cut in my presence under my instructions, and I introduced them

at these conventions, with so many people there present, and explained to them the way we made the pipe and the performance this pipe will withstand.

Q. Do you still have that box and those samples?

A. I have this box somewhere here.

Q. Handing you what appears to be a wooden box a little over two feet long and eight inches wide and high, is that the box to which you have referred?

A. That is the box.

Mr. Stewart: I should like to have the box itself identified as Defendants' next Exhibit.

(Whereupon said box was marked Defendants' Exhibit No. 116 for identification.)

By Mr. Stewart:

Q. Will you take from that box these various samples, and—first tell us whether those samples, all of them, were produced under your immediate supervision.

1452 A. That is correct.

Q. Now, will you explain to the Court what each of those samples represents?

A. Here is a sample (indicating).

Mr. Stewart: Will you mark that Defendants' Exhibit 117 for identification. If the Court please, I would like to just take these as he describes them, line them up and we will put a number on them after he has finished, if that is agreeable.

The Court: Are they being introduced?

Mr. Stewart: Yes, your honor.

The Court: Offered for introduction?

Mr. Stewart: Yes, your Honor.

The Court: Is there any objection?

Mr. Cahill: I have no objection.

The Court: Defendants' Exhibit 116 is admitted.

(Whereupon said DEFENDANTS' EXHIBIT No. 116 was admitted in evidence.)

The Court: Now, we have 117?

Mr. Stewart: I think it would be better to call them 1453 116-A, 116-B and so forth.

(Whereupon Defendants' Exhibits 116-A to 116-E were marked for identification.)

1454 By Mr. Stewart:

Q. Now, Mr. Robinoff, during the recess we have had marked these exhibits which you took out of your box,

the box being defendants' Exhibit No. 116, and each of the five exhibits having been marked as Defendants' Exhibits 116-A, B, C, D, and E.

Now, will you please tell the Court just what those samples are?

A. The first sample was cut out of the pipe in my presence, and then—

Q. When was that done? Can you give the year?

A. I don't remember exactly; about 1930.

Mr. Cahill: Thank you.

A. (Continuing)—and the end of it was submerged in acid, up to a certain point, about here (indicating), to establish which would disintegrate faster, weld, or plate; and, as it appears, the plate started to go first and the weld
1455 was still in good shape. This was cut out of the pipe in the production process.

The other end looks somewhat shiny, because about five weeks ago, in the building where my office is, I went down to the mechanic and asked him to cut a little sample out of it, just for my own purposes. That is sample 116-A.

Here is the bend test (indicating), where we went beyond the requirements to establish if the weld is ductile enough. That sample is 116-B.

Actually, we did not need to press it so far, if we adhered to regualtions, but we did it just for our own edification

By Mr. Stewart:

Q. Mr. Robinoff, let me interrupt you right there.

A. Yes, sir.

Q. Can you state, from the surface of that weld, which flux was used in making the weld?

A. Well—

Q. Can you look at the surface?

A. You see, the surface has been removed, because, in bending it, you have to remove it.

Q. It has all been planed down?

A. (Continuing) But that was clay, lime and ferro-
1456 manganese. I have here a sample of the other.

Q. All right.

A. That is 116-C, where the weld was not removed; it is still there; and where the inside was not removed, it is still there.

As I said, that was simply to establish how far the bend will go if the raised surface would not be removed.

Now, sample 116—

Q. D, I believe that is.

A. Yes, 116-D; that was made by clay-scale flux. Nothing has been removed. It is just as it was.

That was to establish the practical way, as to how far a weld may bend without cracking.

Q. Will you please point out to the Court any differences that appear in the surface of the weld?

A. The clay-scale is very smooth in appearance. The other has a peanut appearance, a peanut shell appearance—that is, the clay, lime and ferromanganese give a peanut appearance; but the clay-scale is extremely smooth.

Q. All right. Please continue.

A. Now, here is a sample that was surprising to me, and still is. While passing through the machine shop,
1457 and seeing the machinist, on a plate planer, removing the top of the weld, I saw, while he was removing it, that it started to curl, and I stood there and observed it curl, to a certain point, until it broke.

I had a photograph of that made, and I have it here, where it shows that this piece was one piece; but only lately, because of handling it too much, showing it to everybody, it broke.

Now it is an impossibility, an absolute impossibility, to make a weld with a bare rod, and it is an impossibility to make a weld with a coated rod, that will ever do the thing than I am showing you here.

Now, the appearance of it is peanut shell again, showing that it was clay, lime and ferromanganese.

These samples I carry with me, all around the country.

Q. You mean all of these samples, do you?

A. All of them, yes, sir. I show them, and I tell them, "Now, that is what we do."

Q. Now, Mr. Robinoff, those samples were also shown at the time your deposition was taken, were they
1458 not?

A. Yes, sir, they were, on August 13th, I believe it was, in Pittsburgh.

Q. And they were not marked for identification at that time, were they?

A. I do not think that they were, no, sir. I showed them to the plaintiff.

1459 Q. Mr. Robinoff, did you take some snapshots in the Christie Park Plant of some welded pipe sections, and at least one test, in the neighborhood of 1930 or 1931?

A. It was even before that.
Q. Before that?
A. Yes, when we experimented with the clay-scale.

1460 By Mr. Stewart:

Q. Handing you, Mr. Robinoff, a photostat of four pages, without saying what it is, and on one of which there appear three snapshots. Will you examine just the snapshots and tell what they are?

Mr. Cahill: I have no objection to the snapshots. You understand that.

Mr. Stewart: Right.

By Mr. Stewart:

Q. Will you state what they are?

The Witness: We made a weld with clay-scale.

1461 We expanded the pipe from 22 inches o.d. to 24 inches o.d., expanded.

By Mr. Stewart:

Q. By "o.d." you mean outside diameter?

A. Outside diameter, yes, o.d. A bare rod electrode we tried. A coated electrode we tried. We never could expand the whole pipe more than that three inches in diameter, which is about nine inches in circumference.

The next picture shows the raise. Then we placed the whole pipe under the hammer with the weld on the side, meaning horizontally, and pounded it down in such a way that the weld had to bend. It bent beyond our ability to go farther.

Mr. Stewart: I ask that this photostatic copy—do you have any objection to the little legend on it or not?

Mr. Cahill: I think we should limit ourselves just to the photographs.

Mr. Stewart: Will you detach these photographs, Mr. Reporter, and mark these Defendants' Exhibits 117-A, 117-B and 117-C.

The Court: Are you offering them?

Mr. Stewart: Yes, your Honor.

The Court: They are admitted.

1462 (Whereupon said photographs, being DEFENDANTS' EXHIBITS Nos. 117-A, 117-B and 117-C, were admitted in evidence.)

1463 By Mr. Stewart:

Q. Mr. Robinoff, in your Christie Park plants, both the tonnage mill and the hammerweld department, where this type of welded pipe was being produced commercially, did the operators wear gas masks?

A. Never.

Q. Or dust masks?

A. Never.

Q. Did the operators wear either helmets, welder's helmets, with the dark glass opening, or use hand shields continuously?

A. They used hand shields, and then at a certain time our safety department insisted upon that we should put little boxes around the descending electrode so as to relieve the man of holding the shield; then he looked through this little box.

Mr. Stewart: No further questions, your Honor. You may cross examine.

Cross-Examination by Mr. Fowler.

Q. You have brought here this morning, among these samples, only one weld made with a clay-scale flux, is that a fact?

A. I don't understand your question.

1464 Mr. Fowler: Will you read the question, please.

(The question was read.)

The Witness: The samples which are brought in here, first a little plate; the bending samples are from different pipe.

Mr. Fowler: Would you read the question again.

(The question was re-read.)

The Witness: There was among the samples one—you asked me clay-scale?

Mr. Fowler: Yes.

The Witness: That is right; that is correct.

By Mr. Fowler:

Q. Now, you recall you testified on your deposition in Pittsburgh on August 13, 1946, do you not?

A. Right.

Q. And you, of course, recall that at that time you were under oath?

A. That is right.

Q. And do you recall that you produced two samples that were made with a clay-scale flux?

A. If I look at them again, I may find that that 1465 is the fact.

Q. If you look at what again?

A. At these very samples.

Q. So the other clay-scale sample is just something you have overlooked?

A. That is possible. If you remember, that was at the very end of my interrogation, when the box was opened, and hurriedly we looked at the samples and departed.

Q. But we did find two clay-scale samples?

A. That is possible.

Q. Well, I will read you the questions I asked and the answers you gave at that time, on page 157:

"Q. Now, the last two samples you produced were made with clay-scale?

"A. Yes, sir."

Do you recall that question and that answer?

A. I do; and I do recall the answer.

Q. Now, you have testified this morning that after your sections of pipe left your welding machines, they went to certain places where tests were made. Do you recall your testimony to that effect?

A. Today?

1466 Q. Yes.

A. Yes.

Q. You recall that at the time of your deposition you gave us certain papers showing the results of those tests, do you not?

A. That is correct.

Q. Is it a fact that somewhere between 25 per cent and 30 per cent of the sections of pipe which left your welding machines failed to pass those tests?

A. No, sir.

Q. Well, I will ask you if you recall that you gave us a paper showing the results of the Moody inspection on an order of pipe, POC 1149, 11½ miles of pipe, 22 inch outside diameter, five-sixteenths wall thickness, finished June 12, 1931.

Do you recall that you gave us that paper?

A. I remember it.

Q. And is it not a fact that that paper shows that there were tested 2,127 pieces of pipe?

A. I wouldn't remember that figure.

1468 Q. I ask you, is it not a fact that this paper shows that only 1,529 pieces of pipe, or 72 per cent, were accepted?

A. That is not true. Now, when you say "accepted", and when you say "failed"—

Mr. Fowler: Just a moment, please. I have had an answer to my question.

The Witness: You said "failed" before.

By Mr. Fowler:

Q. Is this the piece of paper that you gave us on your deposition?

(Handing paper to the witness.)

The Witness: That is right,—2,127 tested. Now then, please do understand it,—I have got to say that—

Mr. Fowler: You have answered my question.

Mr. Stewart: May it please the Court, I ask that the witness be allowed—

The Witness: I have to explain.

Mr. Stewart: (Continuing)—to finish his answer to this question. He has been given a paper that is
1469 being interpreted by counsel. Let the witness himself state what it means.

Mr. Fowler: I have asked him the question as to how many pieces of pipe were tested, and I have asked how many pieces of pipe were accepted as the result of those tests.

You will have the right to develop the matter further on redirect examination, and let the witness at that time make any statement he wants.

The Witness: I would like to answer the question.

The Court: Just a moment. Let us go back and see what the question is. Read the last question, please.

(Question read.)

The Witness: The answer is: Yes.

By Mr. Fowler:

Q. Do you wish now to change your original answer?

A. Yes.

Q. What is your present answer to my question, then?

A. My present answer is that non-acceptance was entirely due to the Finishing Department, which has
1470 nothing to do with the welding whatsoever. There might be non-acceptance in the Finishing Department,

if it was out-of-round, or if it was not cut straight, or for God knows what; but it had nothing to do with the welding.

Mr. Fowler: I will repeat the question.

By Mr. Fowler:

Q. Is it not a fact that this paper shows 1,529 pieces of pipe or 72 per cent, were accepted?

A. Let me ask you, what do you mean? I have to ask you that, to answer the question. What do you mean by the word "accepted"?

Mr. Fowler: I will ask that the witness be instructed by the Court to answer my question.

The Court: Just listen to the question, now, and then answer it.

The Witness: What is the question?

(Question read.)

The Witness: That is true.

By Mr. Fowler:

Q. Now I will ask you if on that deposition you did not give us another piece of paper, which showed the result of final mill inspection on an order of pipe,
1471 PGH-21842, 90.5 miles, 20-inch outside diameter .281 inches—which I assume is about 5/16ths of an inch?

Do you recall that you gave us that paper on your deposition?

A. I believe so.

Q. Is it not a fact that that paper shows that a total of 27,320 pieces of pipe were tested?

A. Yes, that is true.

Q. And is it not a fact that that paper shows that only 20,636 sections, or 75.5 percent, where accepted?

A. What does "accepted" stand for?

Q. I am asking you what this piece of paper shows?

A. It says "accepted", yes.

Q. Have you ever taken or studied a course in chemistry?

A. In my college days, in Aacken, I had, as a mechanical engineer, one semester.

Then of late, about a year or two ago, I got interested in nuclear physics, and I took a one semester course—

Mr. Fowler: Just a moment. I have had an answer.

The Witness: All right.

1472 Mr. Fowler: Nuclear physics is something else.

By Mr. Fowler:

Q. What was the subject matter of the course in chemistry which you had?

A. The fundamental chemical theories of atoms, molecules, and combinations—ground knowledge, in other words.

Q. Do you recall that on your deposition I asked you this question, and that you gave me this answer, at page 13 of the deposition:

"Q. Have you ever studied chemistry?

"A. When I was in college, Kaiser Wilhelm II, as a mechanical engineer I had one semester where they mainly taught us how to make gunpowder, a formula of H_2O.

"That is the extent of my knowledge."

Do you recall that?

A. That is correct.

Q. Have you ever made any studies in the field of electricity?

A. Never.

Q. Have you ever made any study in the field of metallurgy?

1473 A. Never.

Q. Do you recall that you talked with Mr. James F. Lincoln in December of 1942?

A. 1927?

Q. No, 1942.

A. That is correct.

Q. And do you recall that you talked with him at the Pittsburgh Athletic Club?

A. That is correct.

Q. Is it not a fact that at that time he employed you for the Lincoln Electric Company?

A. Not at that time.

1474 Q. When did he employ you?

A. In 1943.

Q. On what date in 1943?

A. The 1st of January.

Mr. Fowler: Now I will read a statement by counsel for the defendants here made at the time of that deposition when I asked the witness as to his duties under his employment, and I am quoting from page 137 of the deposition:

"Our understanding is that although the writing may not cover it, that the arrangement between the parties is

that Mr. Robinoff is to be available in connection with anything that requires engineering advice, and to the extent that this lawsuit may require it his employment does embrace it. I feel free to consult myself with Mr. Robinoff on questions involved in this lawsuit, and I intend to do so."

By Mr. Fowler:

Q. Is that the fact, Mr. Robinoff?

A. That is a fact.

Q. Do you know on what date the Lincoln Electric
1475 Company took a license from the National Tube Company?

A. I do not.

Q. Under your patent?

A. I do not.

Q. You were not consulted in that connection, were you?

A. No.

Mr. Fowler: I would ask counsel for the defendants if they now have that date?

Mr. Stewart: That is one thing we forgot to do.

Mr. Fowler: When do you think you could have that for us?

Mr. Oberlin: I think we can have it by tomorrow morning. I may have to refer it to the home office. Mr. Lincoln does not know.

By Mr. Fowler:

Q. You know there was a John C. Lincoln patent issued several years before the Robinoff patent, do you not?

A. I know of it.

Q. Is it a fact that because of the prior J. C. Lincoln patent that your Robinoff patent was a detailed
1476 patent?

A. I do not understand the legal meaning of the words "detailed patent".

Q. Do you agree with this statement:

"The patent of Robinoff was very much restricted and was largely a detailed patent because of the prior J. C. Lincoln."

Do you agree with that?

A. I do not understand the legal meaning of the whole thing, and therefore I am unable to answer this question.

Q. Well, aside from legal meaning, and giving just

the ordinary meaning to those words, do you agree with that statement?

A. I still do not understand what it means.

1477 Q. You testified yesterday that there were occasions during the course of your welding at Christie Park when there appeared to be no welding action; that time and again, with the clay-scale combination, the arc was not visible; that that was a startling discovery for you; that you would have to look at ammeter and a voltmeter to make sure something was going on, and you gave it the name of submarine arc, and a number of times in your testimony you referred to the submarine arc. Is that not correct?

A. I didn't—

Mr. Stewart: If the Court please, he did not give it the name. That is not the testimony.

The Witness: That is what I want to say, I did not give it the name.

By Mr. Fowler:

Q. You yourself used the term?

A. Yes, because the metal was like submarine, so submarine it was.

Q. Is it not a fact that prior to March, 1929, that due to troubles encountered in producing a sound weld,

1478 you abandoned the idea of submerging the electrode entirely under the flux? Is that not a fact?

A. Not the way you put it.

Q. I ask you whether or not that is not a fact.

A. We didn't abandon the submerging. We abandoned the clay-scale, because it gave us trouble in achieving the certain results for which we were striving. The arc appearance or disappearance is in no way connected.

Q. Well, I will ask you if you agree with this statement:

"Due to troubles encountered in producing a sound weld, we abandoned the idea of submerging the electrode entirely under the flux, and have adopted some other practice"?

A. That is right. That was—

Q. Do you agree with that statement?

A. That is right.

Q. And the other method or practice you adopted was the method incorporated in your patent, is that not correct?

1481 The Witness: I don't know what the patent covers. I read it once, understood very little of it. I don't know what the patent covers.

By Mr. Fowler:

Q. As a matter of historical sequence, you abandoned the idea of submerging the electrode entirely under the flux, and then later on you made your application for the patent to cover some other method that you had adopted; is that a fact?

A. When the application for the patent was made, it was at the time when clay-scale was the only method we practiced.

Q. But that was after you abandoned the idea of submerging the electrode?

Mr. Byron: I object, and I tell you why: Counsel is using a technical phrase, "abandoned". This witness doesn't know what abandonment means, with reference to the application.

1482 The Court: I will sustain the objection.

By Mr. Fowler:

Q. Didn't you use that very expression in the letter dated March 18, 1929, which you wrote to Mr. George A. Reuff, general superintendent of National Tube Company?

A. I believe I did.

Q. And I will read you the first paragraph of that letter:

1483 Mr. Fowler: Plaintiff's Exhibit 102 on the deposition, being a letter dated March 18, 1929, written by Mr. Robinoff, as assistant general superintendent.

Mr. Stewart: No objection.

The Court: Admitted.

(Whereupon the said letter was marked Plaintiff's Exhibit 222 and admitted in evidence.)

Mr. Fowler: "In reference to Mr. A. M. Saunders', secretary of Patent Committee, letter of March 14, 1929, we wish to state that while Mr. Jackson of Mr. Little's office was here, we advised him that due to troubles encountered in producing a sound weld we abandoned the idea of submerging the electrode entirely under the flux and have adopted a practice whereby the electrode continuously moving down from a reel attracts the flux which is magnetic in its characteristics. This method was described in our letter to you on February 25th, 1929. A copy of this

letter was sent to Mr. Saunders. The last paragraph
1484 of this letter describes our present method of welding. We still believe that this particular feature is novel and patentable.

"As a matter of interest and information, we wish that Mr. Saunders be advised of the following: The Lincoln people sell only carbon arc electric welding machines. The method employed in actual use, that is, in machines that they market, is a descending roll, parallel to the carbon, of impregnated paper. This paper produces a slight slag on top of the weld. he quality of the weld is very poor, indeed, and is in no way comparable to our welds. Apparently they abandoned the idea altogether as expressed in their patent 1589017. As to the use of gases to prevent oxidation of weld, General Electric Company has a patent on the use of gases. The General Electric Company calls this method 'Atomic Electric Welding.' As a matter of further interest, when Mr. Lincoln had the opportunity at one occasion to examine the results of our welding, he
1485 asked you (Mr. Rueff) and myself if he could obtain a license on whatever method we used. He apparently was absolutely unsuccessful in the method, as he described in his patent.

"However, all the above is purely a matter of information. We still believe that our method of automatically coating a continuous descending electrode is novel. The suggestion made by Mr. Jackson, that the particles of metal of electrode before being deposited have to go through a molten slag, is not quite true. We are rather of the opinion that the metal melts first and the coating afterwards, because, at the tip the electrode produces an inverted crater.

"We are anxious that this matter should be followed up, as we may be asked within a short time to consider seriously, the installation of an electric welding plant."

Mr. Stewart: What is the question?

By Mr. Fowler:

Q. You wrote that letter, did you not?

A. That is correct.

1487 Mr. Fowler: Well, the patent is in evidence. I will ask the Court's permission to read two sentences from the patent.

The Court: You mean, as the basis of a question?

Mr. Fowler: As the basis for a further question: Page 1, line 40:

"The groove is then filled with a powdered flux composition having a percentage of ground or powdered scale (ferrous oxide) to make the flux magnetizable."

Then from page 2, line 15:

"The V-shaped groove is then filled with a flux having a ferrous metal scale content sufficient to make it magnetic • • •"

By Mr. Fowler:

Q. Are those statements in your patent true?

A. I do not know.

Q. Well, those are in the specifications which de-
1488 scribe what you were doing prior to the time you made the application for the patent, and I will ask you if that correctly describes what you were doing.

A. We observed that while the bare rod descended into the flux, clay-scale, the particles of this clay-scale attached themselves to the end of the electrode at a certain distance.

Why they did attach themselves, either because the steel was wet or there were some other reasons, I am unable to explain.

As a matter of fact, Mr. Jackson, the patent attorney, first drew my attention to it while he observed the welding in the plant. He says, "You see what you are doing there. You have covered the electrode with flux."

I said, "All right, that is what it is."

That is how the name of magnetic attraction came into the picture.

Q. Well, at the time you signed the patent application was that a true statement?

A. That was a true statement as I knew it.

Q. Well, that was the only disclosure in the patent as to how to prepare the flux, was it not?

A. The patent does not talk about flux as a pat-
1489 ented medium. Flux is not a part of this patent.

Q. How much iron oxide did it take to make the flux magnetic?

A. I do not know.

Q. Do you know whether iron oxide is magnetic at welding temperature?

A. I surmise not, but I do not know.

Q. When did you learn that it was not magnetic?

A. I did not say it was not. I surmised it is not. My knowledge is vague. I am not a metallurgical engineer, a chemist or a scientist.

Q. Do you know at what temperature it loses its magnetic properties?

A. Indeed I do not.

Q. Did you perform any experiments to find out whether it was magnetic?

A. No.

1490 Q. You signed the application for your patent saying it was magnetic, did you not?

A. At that time due to the explanation introduced to me, the particles adhered to the rod. That is the explanation.

Mr. Fowler: I move to strike out the answer. I ask for a responsive answer.

The Court: The answer will stand, but the Reporter will read the question again.

(Question read.)

The Witness: Correct.

Mr. Fowler: Now, as a basis for a further question I will read two other extracts from the Robinoff patent, page 1, line 68:

"In carrying out this method the molten metal deposited from the electrode is at all times covered by a layer of the flux in the form of a slag * * *"

The rest of the sentence is not relevant to my present question.

1491 Then on page 2, line 19:

"The operation of welding from this point may be carried out in several ways all of which retain the one fundamental feature of maintaining a relatively heavy coating of flux or slag on top of the molten welding metal and through which the molten metal is deposited so as to prevent oxidation of the metal."

By Mr. Fowler:

Q. Now, you made that statement in your patent application, did you not?

A. That is correct.

Q. And that patent application was dated May 10, 1929?

A. I don't remember the date.

Q. Well, that is shown from the exhibit?

A. Yes.

Q. I show you your signature and the date of execution on the oath. That is your signature, is it not?

A. That is correct.

Q. And does that refresh your recollection as to the date you made that statement?

1492 A. I see there the date in here.

Q. That date is April 30, 1929, is it not?

A. "Sworn and subscribed before me the 30th day of April, 1929."

Q. And that was about five or six weeks after you wrote this letter to Mr. Reuff, was it not?

A. I don't know when I did write the letter to Mr. Reuff.

Q. Well, the date of this letter, Plaintiff's Exhibit 222, is March 18, 1929.

A. So it would appear it is so.

Q. And in that letter, you made this statement:

"The suggestion made by Mr. Jackson, that the particles of metal of electrode before being deposited have to go through a molten slag, is not quite true."

Do you recall making that statement?

A. Yes, sir.

Q. Well, in between the date of this letter and the date you signed the oath to the patent application, what experiments did you conduct to cause you to change your statement?

A. I always thought in this particular explanation to myself, if that did occur in the interim—

1493 The Witness: We didn't conduct any experiments.

By Mr. Fowler:

Q. Now, you have testified on direct about the construction of the electric weld department at the Christie Park plant of National Tube Company, and I believe you call that the donnage mill; is that correct?

A. Correct.

Q. You have also testified that somewhat prior to that time, the A. O. Smith Company had entered the field of pipe making; that is correct, is it not?

A. Correct.

Q. Was it not a fact that National Tube was primarily a seamless mill?

1494 A. Not at that time. It was primarily a butt and lap weld mill.

1495 Q. Well, I will read you this statement from page 29 of your deposition:

"National Tube Company was primarily a seamless mill, with the ability to make seamless pipe up to and including

13⅜ inches in diameter and lapweld pipe up to 25 inches in diameter."

Is that a correct answer?

Mr. Stewart: May I ask that the former part of that be read, so it can be identified as to the time. When? When was it primarily—

Mr. Fowler: I don't believe the deposition identifies it, because this was not responsive to the questions I had asked.

The Court: You may answer the question, and then make any explanation you care to make.

The Witness: The statement is true, but here it is in 1930, '31. The growth of the gas lines was tremendous, and the sizes required were 24, 26, 22; and National Tube Company was stymied, they couldn't do anything. They didn't have the facilities.

By Mr. Fowler:

1496 Q. I am directing your attention to the time when the decision was made to construct the electric weld department, or what you called the tonnage mill; and I ask you if at that time National Tube Company was primarily a seamless mill.

A. No, sir.

Q. At that time did the officials of National Tube Company hold a meeting and decide to spend about $38,000,000 to start experiments, and build a plant to make seamless pipe in larger diameters, up to 24 inches?

A. That is correct.

Q. And did they at the same time decide to spend about two and a half million dollars on an electric welding plant, as a protection against the investment of $38,000,000?

A. That is correct.

Q. Is it not a fact that the production in the electric weld department or the tonnage mill started in July, 1930?

A. Correct.

Q. And that production continued through the balance of the year 1930; is that not a fact?

A. Right.

Q. And during the period from July, 1930 until January of 1931, the electric welding department produced 55,051 tons; is that a fact?

1497 A. That is correct.

Q. And is it a fact that in the year 1931, the plant worked only a few months, and produced 35,077 tons?

A. When you say "a few months", I don't remember the number of months that we ran in 1931.

Q. I will show you this paper, and ask you if that refreshes your recollection any with regard to that.

(Handing paper to the witness.)

A. That is correct.

Mr. Stewart: May we have that paper identified, please.

Mr. Fowler: That is Plaintiff's Exhibit No. 89 on the deposition.

By Mr. Fowler:

Q. And is it a fact that this department was closed in 1932, 1933 and 1934, and operated a few weeks in 1935, producing 1,592 tons?

A. That is correct.

Q. Now, speaking of the commercial production of pipe by electric welding at your Christie Park plant: Is it not a fact that you always used direct current?

A. That is correct.

Q. You never used alternating current?

A. That is correct.

1498 Q. Is it not a fact that the maximum current which you used in commercial production was from 650 to 700 amperes?

A. Yes.

Q. Is it not also a fact that the wall thickness of pipe welded in commercial production in the tonnage mill was 3ths of an inch, or 5/16ths of an inch?

A. That is correct.

Q. And that the wall thickness of the pipe welded in commercial production in the hammerweld production was 3ths of an inch, and ¼ an inch?

A. That is correct.

Q. Is it not a fact that whenever the diameter of the pipe was sufficient for a man to get inside, you handwelded a bead along the inside of the longitudinal seam?

A. That is right, yes, sir, with a coated electrode.

Q. And is it not a fact that you had pinholes in the welds made on your welding machines?

A. Where?

Q. At Christie Park?

A. In what department?

Q. In both departments.

A. We had them time and again, and then they dis-
1499 appeared, and then they came back, and we sawed them off.

Q. And is it not a fact that you did not know as to the causes of the pinholes?

A. I still don't know.

Q. Well, I will ask you, then, if you have any firsthand information with respect to that question?

1500 A. The only firsthand information that I have, is that I sent my chief engineer, an electrician, and a welder there. That is the only fact that I know.

Q. Well, do you not have firsthand information, that you built and shipped them five of your welding machines?

A. We built them in Christie Park—that is true.

Q. And do you not have firsthand information that you shipped them carloads of your complete flux, after it had the lime and ferromanganese in it—

A. That is true.

Q. (Continuing) —and after it was ground and dried?

A. That is true.

1501 Q. Well, did you not have firsthand knowledge of this?

A. No, sir, not as to everything; I would not know that everything was.

Q. Well, what, that you know of, was withheld?

A. We sent them five machines and we sent them three men, and we sent them flux.

That is what I know, and that is all I know.

Q. Did you withhold anything?

A. I didn't withhold anything.

1502 Q. You testified on your direct examination that your welding machines in the tonnage mill had this little box around the arc?

A. Correct.

Q. And that the safety department insisted on putting that box around the arc?

A. That is true.

Q. Well, I will show you a photograph which was produced on your deposition and marked Plaintiff's Exhibit 97 on the deposition (handing document to witness) and ask you if that accurately portrays the operation of a welding machine at Christie Park?

A. Not exactly. The picture was taken, and I directed it, too, for the purpose of showing where the welding is

going on and the arc as it appears to me, and this picture is more exposed than was usually the case.

Q. In what respects does it fail to accurately portray?

A. It shows, to my knowledge and observation of the picture, too much arc.

1505 Mr. Fowler: If the Court please, I ask that this paper be marked as Plaintiff's Exhibit No. 223 for identification. It was marked as Plaintiff's Exhibit 91 on the depositions.

(Whereupon said document was marked Plaintiff's Exhibit No. 223 for identification.)

Mr. Fowler: I should add, that is the paper that shows the Moody Inspection tests on the order known as POC-1149.

I also ask that this other paper be marked as Plaintiff's Exhibit No. 224 for identification, which also shows the results of tests on an order known as PGH-2842. It was marked on the deposition as Plaintiff's Exhibit No. 92.

(Whereupon said document was marked Plaintiff's Exhibit No. 224 for identification.)

Mr. Fowler: At this time I offer these two papers in evidence, marked respectively for identification as Plaintiff's Exhibits 223 and 224.

Mr. Stewart: No objection.

1506 The Court: Admitted.

(Whereupon said PLAINTIFF'S EXHIBITS NOS. 223 and 224 were admitted in evidence.)

Mr. Fowler: I ask that this photograph be marked as Plaintiff's Exhibit 225 for identification, which the Plaintiff has identified, and which was marked on the depositions as Plaintiff's Exhibit No. 97—or rather, I mean to say, the photograph which the witness has identified.

(Whereupon said photograph was marked Plaintiff's Exhibit No. 225 for identification.)

Mr. Fowler: I offer the photograph, Plaintiff's Exhibit No. 225 for identification, in evidence.

Mr. Stewart: No objection.

The Court: Admitted.

(Whereupon said photograph PLAINTIFF'S EXHIBIT NO. 225 was admitted in evidence.)

1507 *Cross-Examination (Continued) by Mr. Fowler.*

Q. Mr. Robinoff, the letter which you saw this morning, and which was dated March 18, 1929, refers to a Mr. Jackson.

I will ask you to state if it is not a fact that Mr. Jackson was patent counsel for the National Tube Company, at that time.

A. For the United States Steel Corporation at that time, —yes, sir.

Q. And was the National Tube Company a subsidiary of the United States Steel Corporation?

A. That is correct.

Mr. Fowler: I ask that this letter dated February 25th, 1929, from the witness to Mr. Reuff, and also this other letter dated February 25th, 1929, from the witness to the same person, Mr. Reuff, the first letter being a short one-page letter, and the second letter being a two-page letter, both be marked for identification as Plaintiff's Exhibits Nos. 226 and 227 respectively.

(Whereupon said documents were marked Plaintiff's Exhibits Nos. 226 and 227, for identification.)

1508 Mr. Stewart: Will you please give me the former exhibit numbers, Mr. Fowler?

Mr. Fowler: Yes, the first letter, the one-page letter, was marked on the deposition as Plaintiff's Exhibit No. 103, and has now been marked as Plaintiff's Exhibit No. 226 for identification.

The two-page letter was marked on the deposition as Plaintiff's Exhibit No. 104, and has now been marked for identification as Plaintiff's Exhibit No. 227.

Mr. Stewart: Thank you.

By Mr. Fowler:

Q. Mr. Robinoff, did you write those two letters, which I now show you?

A. Yes, sir.

1509 Mr. Fowler: I offer the two letters in evidence for the purpose of impeaching the testimony of this witness that he did not know what was in his patent application.

1513 (And thereupon PLAINTIFF'S EXHIBITS 226 and 227 were admitted in evidence.)

Mr. Fowler: Mark this. This is a certified copy of the

file history of the Robinoff patent, No. 1,782,316; and I ask that it be marked for identification.

(Whereupon the said document was marked Plaintiff's Exhibit 228 for identification.)

Mr. Fowler: I offer Plaintiff's Exhibit 228 in evidence.

Mr. Stewart: We have no objection.

The Court: Admitted.

(Whereupon the said document marked PLAINTIFF'S EXHIBIT 228 was admitted in evidence.)

1514 By Mr. Fowler:

Q. I show you the Robinoff patent, being Defendants' Exhibit 103. There is a sketch shown as Figure 2 in that patent, is there not?

A. That is right.

Q. And you will note the position of the welding rod with respect to the flux, do you not? The rod is above the flux?

A. Right.

Q. Now, there is also a sketch shown as Figure 3 on that patent, is that correct?

A. That is right.

Q. And in Figure 3 the tip of the rod is shown down below the molten metal; is that correct?

A. Below the molten flux, you mean to say.

Q. Well, what is the horizontal dotted line supposed to represent there?

A. I really wouldn't know.

Q. And what is the area marked with a "y" supposed to represent?

A. "y"; that is the flux.

Q. Well, if you will look on page 2, line 58, you will find that the area "y" represents the molten metal.

1515 Now, I will read—

A. I don't see that. It says "forming a pool y." It says, "forming a pool y."

Q. Well, let me read the sentence.

"The flux will be continually attracted by the electrode and will be melted so as to maintain a body of molten flux x in said groove below the electrode through which the molten welding material is deposited forming a pool y."

A. It does not say that pool y is metal. It just says "pool y."

Q. Now, quoting from page 2, line [illegible], there is a description of Figure 3:

"In Figure 3 a modified method of this invention is disclosed. In this modified invention the electrode 12 is caused to move down into the body of flux 9 and is then moved forward at a speed to maintain the electrode in close position relative to the flux thereby causing said flux to be melted directly by the arc."

Do you recall that statement in your patent?

1516 A. I read it now.

Q. Can you tell us any more about the modified method shown in Figure 3, than that statement?

A. In which direction, now, do you want me to extend the description as it is made in the patent?

What do you want me to do?

Mr. Fowler: I ask that the question be read to the witness, and that the witness answer the question.

(The question was read.)

A. I could talk for a long, long time about it.

By Mr. Fowler:

Q. Do you remember that I asked you that same question on your deposition?

A. You may have.

Q. And do you recall that you gave this answer, at page 117:

"A. No, sir, I couldn't, because, as I told you before, what actually happens when the electrode descends into the flux,—something is going on there that nobody can see. It is a matter of guessing, and I cannot say a word about it; it is just a guess, what happens there."

1517 Do you recall making that answer?

A. I do recall, but that is only one statement.

Q. Upon what experimental work was Figure 3 based?

A. On what experimental work?

Q. Yes.

A. On the experimental work continued for two and a half years; from 1926 until about 1929, approximately—or rather, three years.

Q. Do you recall that I asked you that same question on your deposition?

A. You may have.

Q. And do you recall that you made this answer, at page 118:

"A. We thought the arc went down through, and dis-

appeared; it was gone. Then it popped out again. We saw the rod descend into the flux. It apparently melts the flux, because we found slag there, but as to what
1518 actually happens underneath, I don't know".

Do you recall making that answer?

A. Yes, sir.

Q. Now, what did you see different when you were welding as shown in Figure 2, and when you were welding as shown by the modified method in Figure 3?

A. The schematic representation of a certain idea, the scheme of the thing, does not convey to you complete understanding as to what we are after.

Mr. Fowler: May it please the Court, I move that the answer be stricken out, and I ask for a responsive answer.

The Court: I will let the answer stand, but I think the question should be re-read to the witness.

(The question was read.)

1519 A. As it is shown schematically, No. 3, that is correct. As it is shown in No. 2, the rod appears to be way out of the flux. I did not make this drawing. I did not make it.

By Mr. Fowler:

Q. You signed the application and you had the drawing annexed to it, did you not?

A. Yes. That is correct, based on my drawing.

Q. Now, I will ask you. Was there some voluntary control that you used so that you could have a weld as shown in Figure 2 or that you could have a weld as shown in Figure 3?

A. As it looks to me today, Figure 2—that is a sketch which is incorrect.

Mr. Fowler: Now I ask that the question be re-read and the witness be instructed to answer. I move to strike out that answer.

The Court: The motion is denied, the latter motion. The Reporter will read the question, please.

(Question read.)

The Witness: I do not understand the name of "voluntary control". What does it mean? What does it mean, "voluntary control"?

1520 The Court: You mean, you cannot answer the question?

The Witness: I cannot, no.

By Mr. Fowler:

Q. I will ask you if you recall that I put you these questions on your deposition and that you gave these answers, reading from page 118:

"Q. Well, was there some voluntary control that you used so that you could have a weld as shown in Figure 2 or that you could have a weld as shown in Figure 3?

"A. No. I do not think so. I have no recollection of that.

"Q. You would not change the flux?

"A. No.

"Q. You would not change the voltage?

"A. No. As to why that distinction is made there, honestly, I could not tell you.

"Q. Would you know today how to construct a process so that you would have welding as shown in Figure 2 of your patent?"

Mr. Byron: Figure 3.

By Mr. Fowler:

Q. (Continuing):

1521 "A. I would say no.

"Q. Well, would you be able today to construct a process so that you would have welding as shown in Figure 3 of your patent?

"A. I believe so.

"Q. So you could not shift from one to the other?

"A. The General Electric head was out, in, out, in, under the flux, above the flux, under the flux, above the flux, and so we could not. I am talking about particularly the welding head which was used in our plant."

Do you recall those questions and those answers?

A. Yes, sir; and they are correct.

Q. When you were welding with your clay flux process, is it not a fact that you did not know whether the end of the rod was in contact with the molten flux?

A. I don't know.

Q. Is it not a fact that you do not know whether your flux was electrically conductive when molten?

A. I don't know.

Q. Is it not a fact that you failed to make any experiments or tests about that?

1522 A. Correct.

Q. And that your experimentation was a topsy turvy affair?

A. Yes, a plant proposition and not a laboratory venture.

Q. You did not keep any data on your experiments?

A. No, sir.

Q. And no one else kept any data on your experiments?

A. No, sir.

Q. All three of you, you, Paine and Quillen, were all attached to the operating end, and your experiments were just a pastime; is that not a fact?

A. A side issue.

Q. You state that the greatest advantage in using your clay flux is that it prevents the heat escaping as fast as when the molten area is exposed to the air, do you not?

A. That is correct.

Q. Now, you have given us, on your direct examination, the analysis of your clay-lime-ferro-manganese flux, that is, the 89 per cent clay, 9 per cent lime and 2 per cent ferro manganese; that is correct, is it not?

A. By volume.

Q. And that flux did not have any iron oxide in it is that correct?

1523 A. It didn't unless clay has some admixtures in it. I wouldn't know.

Q. And that clay-lime-ferro-manganese flux was the only flux you used for commercial production in your plant; is that correct?

A. That is correct.

Q. And did you call welding with that flux a submarine arc?

A. This name stayed until the end of the day, submarine arc.

Q. And is it not a fact that you adopted that clay-lime-ferro-manganese flux because previous fluxes gave too much trouble? Is that not a fact?

A. Correct.

Q. And you abandoned clay-iron-oxide flux and substituted the clay-lime-ferro-manganese flux in the spring of 1929; is that a fact?

A. Sometime in the end of the year 1929 and beginning of 1930, when we were forced to build the building and start to manufacture.

Q. And that was a matter of several months prior to the issue of your patent of November 18, 1930, covering this clay-iron oxide flux; is that not a fact?

A. I want you to understand—

1524 Q. I am asking you for a fact.

A. I don't know what happened with my application. I never heard of it until a copy of the patent was sent to me, for my signature.

Operating men are not in contact with the lawyers.

Mr. Fowler: Would you please read the question.

(Question read.)

The Witness: The dates are correct.

By Mr. Fowler:

Q. Is it not a fact that there was a policy of secrecy on the part of the National Tube Company, about its electric welding?

A. Only at the very beginning.

Q. Well, I will ask you if you recall this question, and your answer, at page 116 of your deposition:

"Q. Was there a policy of secrecy on the part of National Tube Company about your welding?

"A. At the beginning, yes, they did not permit anybody to come in. None of the suppliers of machinery were permitted into the plant, because we all considered that this is a novelty of such extreme importance that we

1525 thought it better not to acquaint the public with it, especially the General Electric and Westinghouse.

"Q. Did there come a time when you changed that policy?

"A. Yes, about 1935. They did not care any more about it at that time. It was half dead; they did not care.

"Q. Did that same policy apply to your ingredients of flux and the formula for its preparation?

"A. I was not told so, but I, for my own protection, did not talk to anybody about what we did.

"Q. What about the other two inventors?

"A. They did not talk about it either. I hope so, I don't know."

1526 A. Every word is correct.

Mr. Fowler: No further questions.

Redirect Examination by Mr. Stewart.

Q. Mr. Robinoff, Mr. Fowler has already offered in evidence as Plaintiff's Exhibits Nos. 223 and 224 respectively, certain inspection reports.

Will you please look at your copy—

A. Mine is not marked that way. Will you please tell me which is which plaintiff's exhibit?

Q. The first one is POC 1149, at the top.

A. I have it.

Q. Now, you will recall, when he first started to cross examine you before lunch, he asked you whether that report showed under the heading Tested, 2,127 pieces, and Accepted, 1,529 pieces.

Will you please explain what the word Accepted means, and then what all of the other words in the column mean, also?

A. The pipe had to start from a plate, and it had to go through the forming department, the welding department, and the finishing department.

Each one of those departments had its own troubles, in that machines would be out of order, and the dies
1527 would shift; or in the finishing, when they cut the pipe, its plane with the axis might be on an angle.

There are so many items that enter into pipe, that "accepted" means this, that after welding, it was accepted, nothing was done to it; and then upon examination by the inspectors, they found out all kinds of defects in there, and some of them were attributed to the welding, and some of them to the finishing department.

But often in welding, it has nothing to do either with the flux, or with the arc. It may be that the backing bar was burned—

Q. Never mind what might cause it, Mr. Robinoff. Will you just explain the meaning of "accepted", and then of those other words.

A. Now, for instance, take leakers: that means that when the pipe was placed in the testing machine, and subjected to a pressure of 50 and more per cent than in the field, there might have appeared certain bubbles in the weld.

"Bursted" means that under pressure, the pipe simply ripped open, and let all of the water out.

1528 Q. Now, in this first report that you are looking at, the leakers were 80 out of 2127: is that correct?

Mr. Cahill: I object to that. The document itself is the best evidence of what appears thereon.

The Court: Yes.

A. Yes, that is correct.

By Mr. Stewart:

Q. All right. Will you just go on down, now, please, and explain—

A. Bursted, zero.

Mr. Cahill: Just a moment. I object to his reading the figures into the record. I have no objection to his explaining what the entries mean.

Mr. Stewart: If the Court please, this was put in as though 25 per cent of the pipe were defective because of the welding. I am only trying to clarify this document that was utterly and completely confused by the plaintiff.

The Court: Proceed with your question, Mr. Stewart.

1529 By Mr. Stewart:

Q. Continue.

A. Bursts, 0. Cracked ends, 1. Weld repairs, 99. Resize—here is where the finishing starts. Up to the point of weld repairs, it is all the welding end and the performance end, and from here on it is all the finishing end.

In view of the fact the pipe had to be deadly accurate in diameter, we had to re-size the end. It has nothing to do with welding.

With respect to refacing, often our finishing men cut the end of it on a bias. We have to reface it and regrind it. The end of the weld had to be ground off because a coupling had to go over it, and the weld was in its way.

Thin ends were due partly to plates and partly to many other things too complicated to go into here and describe them. Dress marks were due to the die shifting and making flat spots on the pipe, which was not acceptable to our inspectors. This is due to the press.

Clean rust. That was due to the rusty plates. Repair defective steel. Often the steel or the parent metal, as we call it, had defects and we had to repair the Carnegie-
1530 Illinois steel.

Rejected, 8, meaning that of all the pieces we submitted, eight were rejected, which is four thousandths of one per cent, 8 divided by 2127.

Mr. Cahill: That is not a correct reading of the exhibit. He left out two important words, "rejected on account of defective steel."

The Witness: It says "rejected on account of defective steel."

Mr. Cahill: If you are going to read, you have to read the whole thing.

The Witness: All right.

Mr. Stewart: That is right.

By Mr. Stewart:

Q. Do you stand corrected, Mr. Robinoff?

A. Yes. I do stand corrected.

Q. Now, looking at what has been marked Plaintiff's Exhibit 224, which in your papers begins with key number PGH 2842, 90 1/2 miles, 20 inch outside diameter, final mill inspection, Moody—is that correct?

A. That is correct.

Q. "Moody" means the Moody engineering firm?

1531 A. An outside concern, yes.

Q. They were retained by the purchaser and not by you?

A. That is correct.

Q. Is the same type of explanation applicable to the wording of those words?

A. Yes. The same thing.

Q. Beginning with the word "resize" is everything after that unrelated to welding?

A. Absolutely unrelated.

Q. Now, Mr. Robinoff, in your cross-examination you were shown two letters which you wrote to Mr. Reuff relating to your attempts to get your patent. Yesterday I believe you testified that you did send a letter before 1929 as an initial effort to get your patent to your superiors, is that correct?

A. That is correct.

Q. And that letter with enclosures was yesterday identified as Defendants' Exhibits 108, 109 and 110. Was that the initial description—

A. Yes.

Mr. Cahill: I object to any leading—

The Witness: It was.

Mr. Cahill: —in this connection.

1532 By Mr. Stewart:

Q. What was the first description of your invention submitted to your superiors?

A. That was the very beginning. Please let me see it.

Q. Will you look at all three of those and identify them, please?

A. That was the first time that I made acquainted our superiors, or my superiors, with what we had been doing, and asked them to obtain a patent.

Mr. Stewart: We offer that in evidence, your Honor.

Mr. Cahill: May I have just a moment?

The Court: Is that the same one as you previously offered?

Mr. Stewart: That is the same one we offered yesterday.

Mr. Cahill: May I just look at it a second, the copy I have?

The Court: Yes.

1533 Mr. Cahill: May I see a copy of it?

Mr. Stewart: It was an enclosure. There is a covering letter.

Mr. Cahill: I renew my objection of yesterday. The exhibit now offered is entirely self-serving. It in no way affects what was done on cross-examination, because the point on cross-examination was that this witness said that he didn't know what was in his patent application.

The Court: I understand your position.

Mr. Cahill: That goes to impeachment.

The Court: I understand the distinction.

Mr. Cahill: I am not going to bore you with repetition. It is entirely improper to offer something replete with self-serving declarations, and I submit the rules are different.

The Court: If you have some cases you want to cite, I wonder if it wouldn't be better to have these cases and I could read them later, and I would have the authorities in that respect.

Perhaps you could go to something else instead of taking the time out. If this witness is going to be here,—

Mr. Stewart: He wants to leave town.

1534 Mr. Cahill: In order to save time, I will stipulate that I will not raise the objection on the fact of his absence or anything that goes to the authenticity, to the extent the witness has heretofore identified the documents. My objection goes to the substance, the essence of the testimony, not to any such identification as he has given.

The Court: Suppose I take your authorities, and I had in mind not taking time out now.

Mr. Stewart: Yes, that is all right.

The Court: Is that agreeable, Mr. Stewart?

Mr. Stewart: It is only the sequence I had in mind. I would like, in view of what has taken place on cross-ex-

amination of this witness, to be permitted to read his first description and then the second, in the course of this examination.

The Court: If it is read and eventually allowed in evidence, your purpose is served, is it not?

Mr. Stewart: I would like it read right in the record.

The Court: I don't understand you. Read by the witness?

1535 Mr. Stewart: Yes.

Mr. Cahill: I take it the purpose of putting the writing in is so Mr. Stewart won't have to rely on what the witness said.

Mr. Stewart: That is right.

Mr. Cahill: So what difference who reads it?

The Court: I don't see what difference that would make, as to probative value or admissibility, if they are in evidence, as to who reads them or whether they are read at all.

Mr. Stewart: As corroborative of all the testimony he has given. That is the reason that the Patent Office permits such things to be used, not as self-serving declarations but as corroboration.

The Court: Go ahead.

Mr. Byron: First I call attention to Treatise, Interference Law and Practice, by Charles W. Rivise and A. D. Caeser, and particularly to pages 345, 346, 347 and 348, wherein reference is made to certain decisions.

Then I call attention to the case of *Harper* v. *Zimmermann* reported in 41 F. 2nd, 261, at the bottom of page 265.

1536 Mr. Cahill: You don't want to hear argument, I take it?

The Court: Well, it seems to me we can save some time.

Mr. Cahill: I agree with you.

The Court: And if you care to see these before—

Mr. Cahill: At a recess.

The Court: —or afterwards, and submit anything in addition, you may do so.

Mr. Cahill: Yes.

The Court: (Continuing): And the matter will still be reserved.

By Mr. Stewart:

Q. Mr. Robinoff, after you sent your first communication to Mr. Reuff in October or the end of September—

October, 1927, what happened thereafter with respect to your efforts to get a patent application drawn?

A. I received a number, quite a number, of patents describing the previous art.

Q. From whom did you receive them?

A. It was apparently through attorneys, superior to me. I had them in my hand.

1538 Q. Mr. Robinoff, was the J. C. Lincoln patent among those submitted to you for examination?

A. It was.

Q. Let me ask you this question, Mr. Robinoff: Will you identify the drawings in the J. C. Lincoln patent, and in your original sketch?

A. There was in the J. C. Lincoln patent 1,589,017, one particular figure, No. 4, which showed a flux—

1539 The Witness: Yes, figure 4.

By Mr. Stewart:

Q. And to what was that similar, in your own drawing?

A. No. 1,—I believe it was No. 1.

Q. You had better look at it.

A. Yes, sir, that is correct; No. 1. It was No. 4, and No. 1, my sketch No. 1, and Lincoln No. 4; flux—flux.

Q. What about your sketch No. 3, Mr. Robinoff?

Mr. Cahill: I object to any leading being done in this connection, may it please the Court. I move that counsel be admonished not to lead.

This is a question, now, that ought to be left to the witness entirely, and not have it suggested to him, to compare particular ones.

The Court: Yes, the objection is sustained.

The Witness: May I say—

The Court: Just a moment. There is no question pending.

The Witness: I cannot answer?

1540 Mr. Stewart: No.

The Court: No.

By Mr. Stewart:

Q. Mr. Robinoff, will you look at the other drawings in your own patent, the other figures in your own drawing, that is, and also in the John C. Lincoln patent, and state whether or not there are any more which are similar.

Mr. Cahill: I submit that does not cure the vice, your Honor. The answer having been supplied in the previous

question, the probative value of the answer of the witness now has been completely destroyed.

The Court: He may answer.

A. Sketch No. 3, just looking at it again, resembles far more closely Lincoln No. 4, just by looking at it again.

By Mr. Stewart:

Q. Now, Mr. Robinoff, after you examined the patents which were sent to you by the National Tube or United States Steel Corporation Patent Department, did you have any further correspondence or discussions with the patent attorneys?

A. Yes, sir.

1541 Q. And over what period of time did that extend?

A. For a year or two.

Q. What patent attorneys in National Tube or United States Steel Corporation were made available to you to discuss your application?

A. In Pittsburgh, Mr. Little and Mr. Jackson—in the Pittsburgh district.

Q. Was there anyone outside of Pittsburgh?

A. Mr. Usina, in New York, the general patent attorney.

Q. Usina?

A. Yes, sir.

Q. Where did you see him?

A. In New York.

Q. That was in his office?

A. In New York.

Q. In his office?

1542 A. Yes, sir.

Q. Among the communications which you sent in connection with your application, or your endeavor to get an application for a patent, was there a letter dated February 25th, 1929, addressed to Mr. George A. Reuff, previously identified as Plaintiff's Exhibit No. 104?

A. I would like to see that, please, if I may.

Q. Yes.

A. Yes, sir; I wrote it.

1543 Q. Was there a designation or a phrase used by you in communicating with Mr. Reuff, as a name for your process?

A. Yes, there was.

Q. What was that?

A. Portable electric furnace welding method.

Q. Portable—

A. Portable electric welding furnace method.

1544 Q. Now, did you send a communication with respect to your invention to Mr. Reuff, consisting of 1545 four pages, dated February 24, 1928?

A. Yes, I did.

1546 By Mr. Stewart:

Q. May I have it, please?

A. Yes.

(Handing document to Mr. Stewart.)

Mr. Stewart: That was Plaintiff's Exhibit 80.

Q. Were the snapshots previously referred to in your testimony a part of that report?

A. Correct.

Mr. Stewart: They were identified and admitted as Defendant's Exhibits 117-A, 117-B and 117-C. We offer this exhibit, your Honor, as Defendant's Exhibit 118.

(And thereupon said instrument was marked Defendant's Exhibit 118, for identification.)

Mr. Cahill: That was earlier offered and I objected to it, and that is one of the things—

The Court: Is that in the same category?

Mr. Stewart: The same category.

1547 By Mr. Stewart:

Q. Now the application for your patent you have already testified bears the date of May 10, 1929. From that time on, after you executed your application what if anything did you have to do with its prosecution?

A. Nothing at all.

Q. Did you prepare the drawings which appeared on the first page of your patent when it was issued?

A. No, sir.

Q. Mr. Fowler asked you a question whether or not you did not submit in Pittsburgh, at the time your deposition was taken, only one sample of a weld made with clay and scale flux.

Mr. Cahill: May I have that question read?

(Question read.)

Mr. Cahill: That is not what Mr. Fowler said.

Mr. Fowler: No.

Mr. Stewart: I mean, two. Two samples.

By Mr. Stewart:

Q. He asked you that?

A. He did.

Q. And he asked you whether here in your box there was only one offered as part of your testimony?

1548 A. But I submitted—

Q. Just answer yes or no.

A. Yes.

Q. Did you have another one here at the time you testified?

A. This morning, yes.

Mr. Cahill: May I ask if this was in the box that is now being produced, your Honor?

Mr. Stewart: No, sir.

Mr. Cahill: As a preliminary question.

Mr. Stewart: No. These were offered yesterday, that is all.

The Witness: Yes.

By Mr. Stewart:

Q. Yesterday, Mr. Robinoff, you identified and there were admitted into evidence Defendant's Exhibits 106 and 107. Will you tell the Court whether either of those weld samples were made with clay and scale flux?

A. Both of them are clay-scale.

1549 Q. Where did those pieces come from? First, Mr. Robinoff, where were they made?

A. *In Christie Park.*

1550 Those two exhibits were made with clay and scale flux at Christie Park?

A. Correct.

Q. Was one of those two exhibited and shown to Mr. Fowler at the time your deposition was given?

A. Both of them.

Mr. Stewart: That is all, your Honor.

Mr. Cahill: Nothing further.

Mr. Fowler: No further questions.

(Witness excused.)

1551 Mr. Byron: May it please the Court, at this time we would like to read portions of the deposition of Mr. James B. Quigley. He is now in Florida, and this deposition is one taken by the plaintiff, Quigley being called as an adverse witness.

The first part of this deposition was taken February 4, 1946, Mr. Wolfe examining.

1560 Mr. Byron: Starting now with Mr. Quigley's deposition examination by Mr. Wolfe:

"Q. What is your full name?

"A. James B. Quigley.

"Q. Where do you reside?

"A. Hammond, Indiana.

"Q. What is your present employment?

"A. Welding supervisor, Graver Tank & Manufacturing Corporation.

"Q. How long have you been employed by that company?

"A. It was seven years last October.

1561 "Q. What was your employment previous to that?

"A. Previous to that I was welding supervisor on a bridge for the Florida East Coast Railroad.

"Q. Had you ever worked for any Graver Company prior to the time you started to work for Corp.?

"A. Some seven years ago."

The Court: Who?

Mr. Byron: "Corp." I suppose that means, corporation.

"Q. Have you ever been employed by the Lincoln Electric Company?

"A. I was.

"Q. When was that?

"A. From 1937 to 1938; it was just about a year, February to February.

"Q. What work did you do for them?

"A. I was welding instructor in their welding school.

"Q. Down in Cleveland, is that?

"A. Yes.

"Q. Have you ever gone back there to do any

1562 instructing or anything of that kind since that time?

"A. No.

"Q. Where did you get your training in engineering and welding?

"A. I went to school, to Western Reserve University, in Cleveland, and then I did some night school work, and my welding education was had at the Lincoln Electric Company in Cleveland.

"Q. You went to their school, and then subsequently you were an instructor in it, is that right?

"A. That is so.

"Q. Is it correct that when you first went with the Graver Corp., you started out as a superintendent of welding?

"A. Welding supervisor.

"Q. Welding supervisor?

"A. Yes.

"Q. And you have held that same title throughout, is that right?

"A. That is right."

Mr. Byron: Now I will stop on page 125 of the deposition, and I am going to jump over to page 141.

1563 "Q. What do you do with the unfused portion of the flux?

"A. We pick it up.

"Q. Do you have a vacuum pickup of some kind for that purpose?

"A. We do not use a vacuum pickup. It is manual.

"Q. You put that back in the hopper and use it over again, do you?

"A. Yes.

"Q. Is the fused flux that remains on top of the weld a quite brittle, glassy substance that breaks off easily?

"A. Yes. It breaks off easily.

"Q. Is that thrown away?

"A. Yes.

"Q. Do you use at least approximately the current and voltage values and speeds recommended in this Lincoln catalogue?

"A. Without a thorough examination of this I do not believe that I would be qualified to say, right now.

"Q. Do you have tables, whether in that catalogue 1564 or not, that are furnished by The Lincoln Electric Company that you do use as a guide?

"By Mr. Van Duzer: You say, 'as a guide'.

"By Mr. Wolfe: Yes.

"By The Witness: Yes. They have furnished tables at different times.

"By Mr. Wolfe:

"Q. And you generally adhere to the values that they recommend?

"A. That is right.

"Q. Their catalogue says at the top of page 4,—and when I say 'their catalogue', I mean Plaintiff's Exhibit 4—'absence of smoke, fumes, radiated heat, spatter and visible arc eliminates the discomforts of conventional open arc welding and results in an increased operating factor for lower welding costs.'

"Have you found that to be true in your use of the Lincolnweld process?

"A. Will you read that again?

"Q. I will be glad to show it to you.

"(Handing same to the witness.)

1565 "A. With some reservations, yes.

"By Mr. Van Duzer: You are entitled to state your reservations as well, if you want to.

"By The Witness: Well, I do not know that I need to go into that.

"By Mr. Van Duzer: All right.

"By Mr. Wolfe:

"Q. Do your operators on this Lincolnweld process use eye shields or goggles such as are commonly used with bare rod welding in an open arc?

"A. No, but they wear a tinted goggle.

"Q. They do not use shields?

"A. No, they do not use shields.

"Q. Do they wear masks of any kind?

"A. No. There are time when the arc flashes through, that necessitates the tinted goggles.

"Q. Flashes through what?

"A. It comes up through the flux.

"Q. And except for those occasions, you do not see anything of the arc, is that right?

"A. That is right."

1566 Now, skipping over to page 153 of the deposition, starting at the bottom of the page:

"Q. What is the length of time required to train a man to operate one of these Lincolnweld installations?

"A. That depends on the individual, to a large extent; and another thing, I think possibly I take longer to train a man than some places might. I insist that most of our operators have a manual welding background. In other words, they must be a manual operator before they operate an automatic welding machine.

"Does it take considerably longer to obtain the skill and

manual dexterity that you acquire in hand welding than for a man to go on and learn to run the automatic machine?

"A. The way I do it, I think it takes longer.

"Q. Can you make any very direct comparison, at least on the basis of averages?

"A. It will take a welding operator at least a year
1567 before he is qualified to work in our shop at all on a code class of work, so you can figure it takes that much time, it takes a year plus, say, a probationary period of three months before he is allowed to operate an automatic welding machine.

"Q. What do you mean by a code class of work?

"A. That is A S M E code that we work to.

"Q. And that is a very critical and difficult type of work, is it?

"A. Yes.

"Q. Is that about as difficult as any welding work that is done?

"A. I think so.

"By Mr. Wolfe: I think that is all for the present. I think we can adjourn this.

"By Mr. Oberlin: With the same understanding as in the case of the adjourned examinations of the other witnesses?

"By Mr. Wolfe: Yes."

Now, we will refer to a continuation of Mr. Quigley's deposition taken on May 21, 1946, starting at page 160:

1568 "By Mr. Wolfe: The plaintiff made a motion under date of March 13, 1946, for the discovery and production of documents and other things, and the Court, under date of April 24, 1946, granted certain of the items described in the motion.

"One of those items was an inspection of the Lincolnweld process as practiced at the Graver plant in East Chicago, Indiana.

"We are met this morning pursuant to that order for inspection of the process, which it has agreed between counsel shall be demonstrated by the welding of certain specified sizes or thicknesses of test plates, and the size of the plates welded, and other operating data to be reported as the demonstration progresses.

"By Mr. Oberlin: It is noted that the Lincolnweld process is properly characterized as an arc welding process.

"And the said J. B. Quigley, of lawful age," and so forth.

"*Examination by Mr. Wolfe.*

"Q. The first run you are going to make is on half inch plate, is that right?

"A. Half inch plate.

"Q. What is the length of the test?

"A. 36 inches. Those are 8 inches wide.

"Q. And they are tack welded at the space points, is that right?

"A. That is right.

"Q. There is no beveling or scarfing of the edges?

"A. No, none at all.

"Q. No backing up bead?

"A. There is no backing bead used on those at all.

"Q. Does that conform with your general practice for half inch plate?

"A. That is true. If we had a bad fit, we would have to put a seal bead on there to back that up.

"Q. What size electrode is being used?

"A. 7/32.

1570 "Q. Do you intend to use the same electrode throughout all the runs?

"A. That is right.

"By Mr. Van Duzer: I just came here. Is this part of the deposition, or is it just notes?

"By Mr. Wolfe: It is part of the deposition, yes.

"By Mr. Wolfe:

"Q. The flux that you are going to use is a bag of the regular Lincolnweld 660 flux?

"A. That is right.

"Q. What travel speed do you intend to use on this first run?

"A. We will be running between 15 and 18 inches.

"Q. What voltage do you intend to use?

1571 "A. The voltage will run about 35 or 36 volts.

1572 "Q. What current do you intend to use?

"A. 650 to 700 amps.

"Q. To start the process, you will put a wad of steel wool under the electrode?

"A. That will not be necessary.

"Q. I think your previous testimony was, that was the regular starting practice?

"A. We have done that in the past, but with the newer heads it is not necessary to do that.

"Q. What current are you going to use on the second pass?

"A. 800 to 850 amps, 36 to 38 volts.

"Q. The same travel speed?

"A. The same travel speed, 15 to 18 inches.

"By Mr. Oberlin:

"Q. You spoke of a second pass; a second pass over a previously deposited weld or a second set of plates, are you referring to?

"A. No; this will have just one pass from each side.

"By Mr. Wolfe:

"Q. And the second pass will be on the reverse?

"A. On the reverse side, that is right.

1573 "By Mr. Van Duzer:

"Q. Will absence of the ball of steel wool make the representation anything other than accurate?

"A. No.

"Mr. Van Duzer: Are you satisfied, Mr. Wolfe, with the manner of the demonstration? I mean, if you have any complaints, I think we ought to have them in the record now.

"Mr. Wolfe: So far as I can tell now.

"Mr. Van Duzer: Thank you."

Then at that time 1-A, 1-B, 2-A and 2-B were run.

"By Mr. Wolfe: On the first plate, we will mark the first set welded 1-A, and the second set 1-B, and the second one will be marked 2-A, and 2-B, and so on through the series.

"By Mr. Wolfe:

"Q. This second one that was listed, plate No. 2: How did the conditions under which it was welded compare with those which you set up for the first plate?

"A. Our voltage was a little bit less.

"Q. It is the same size plate and the same fit-up for it?

1574 "A. That is right.

"Q. Plate No. 3—that is the next step you are going to run, will be what size plate?

"A. 3/4 inch plate.

"Q. Now has that been prepared?

"A. That has a double bevel, and the groove on one side is 1 8th of an inch deep; a 60 degree bevel, that is, including the angle. There is a 1 4 inch nose, and there is a 60 degree bevel on the reverse side, 3 8ths of an inch deep.

"By Mr. Oberlin:

"Q. You say there is a bevel on both sides. Actually, the abutting edges of the plates were grooved or bevelled so that when the edges are brought together, there is a V-groove in effect.

"A. Yes, sir.

"Q. And what you have been describing are the V-grooves on the opposite side of the two adjoining plates?

"A. That is right.

"By Mr. Wolfe:

"Q. Then you had the operator put a bead along 1575 groove on one side with a hand electrode, did you?

"A. Yes. He welded on one side, due to the poor fit-up.

"By Mr. Oberlin:

"Q. That is the No. 3 plate?

"A. That is the No. 3 plate.

"By Mr. Fowler:

"Q. What speed will you use on this 3 4 inch plate?

"A. 12 to 15 inches per minute.

"By Mr. Oberlin: That is the No. 3 plate.

"By Mr. Fowler: Yes, No. 3 plate.

"By the Witness: (Continuing.) 650 to 700 amps; 36 to 38 volts; and the reverse side will be the same speed, 12 to 15 inches a minute, 900 amps, 37 to 39 volts.

"By Mr. Fowler:

"Q. Are you using A.C. or D.C.?

"A. That is D.C.

"Q. All of it?

"A. That is all D.C.

"Q. With straight or reversed polarity?

"A. Reversed polarity.

"By Mr. Wolfe: I think we can go ahead with 1576 No. 3."

Then there is the notation that 3-A, 3-B, 4-A, 4-B, 5-A, 5-B, 6-A and 6-B, were run.

"By Mr. Wolfe:

"Q. Mr. Quigley, the conditions used on plate or sample No. 4 were the same as for No. 3, is that right?

"A. Plate preparations?

"Q. Plate preparations, and the same welding conditions.

"A. No. The plate preparation was not the same on the 1-inch, as on the 3/4 inch plate.

"Q. Samples 3 and 4 are the two 3/4 inch plates?

"A. Yes.

"Q. Those were the same?

"A. Those were the same.

"Q. The same preparation and same welding?

"A. Same preparation and same welding.

"Q. For Plates 5 and 6—those are one inch plates; is that right?

"A. That is right.

"Q. What preparation did you use on those?

"A. 60 degree bevel from one side, and 3/8ths
1577 of an inch deep, 1/4 nose; 60 degree bevel on the reverse side, 3/8th of an inch deep.

"Our amperage was running 800; 38 volts.

"On the reverse side, we were running 1050 to 1100 amperes; 38 to 40 volts.

"Q. In the final run on plate No, 6, you were running up to 42 volts; is that right?

"A. He took the reading. I was over there for the end of that, and at that time it bounced over to 42, at times there.

"By Mr. Wolfe: A comparison of these voltages with those recommended in the Lincoln Company operating data table, will of course show for themselves, that in all the plates 3, 4, 5 and 6, the operating voltages used were in excess of those recommended.

"I would like to have the record show that I asked Mr. Oberlin to cut down to the rated value, and that he refused.

"By Mr. Wolfe:

"Q. So that what was done here was in accordance with your operating practice?

"By Mr. Van Duzer: What question are you putting to the witness?

1578 "By Mr. Oberlin: May I hear it, please?

"(Record read by the Reporter as above recorded.)

"By Mr. Van Duzer: What is the fact about that, Mr. Quigley?

"A. These plates were run off one of our regular automatic welders. The procedure was largely as set up in our every day work.

"Q. Do the tests reflect the normal commercial operating conditions?

"A. They do.

"By Mr. Van Duzer: That is all.

"By Mr. Wolfe:

"Q. Do you have any tables of operating data that you supply your operators?

"A. We don't have any fixed data. We have had tables in the past, that we have used when we were setting up procedure. However, a good automatic job is largely due to a good operator. There are not any of these fellows that use a fixed table. Your operating conditions from day to day will change.

1579 "By Mr. Wolfe: As to this matter of samples, Mr. Oberlin, I suggest that we have these sample plates cut approximately in half, so that each of us may have a half of each of the sample plates.

"By Mr. Oberlin: The plates that have been produced in the course of the demonstration today have been carefully preserved, and a division of them between the parties will be arranged by agreement between counsel. For the time being, they will be retained by the Graver Tank & Mfg. Corp. in this plant where they have been made.

"By Mr. Wolfe: We would also like to have a fairly large sample of the flux that was used this morning, and a length of the welding rod that was used.

"By Mr. Oberlin: That will be provided, although we have already furnished you with two bags of Lincolnweld 660 flux.

"By Mr. Wolfe: You can appreciate it is necessary to make tests in connection with the demonstrations that were run here this morning.

1580 "By Mr. Oberlin: Do you want a sample out of the particular bag that was used here this morning?

"By Mr. Wolfe: That is right.

"By Mr. Oberlin: I do not know how much is left out of that bag.

"By Mr. Wolfe: I suppose 5 or 10 pounds.

"By Mr. Oberlin: We will divide whatever is left between us.

"Mr. Quigley, will you see that that bag is preserved, and we will arrange later?

"By Mr. Quigley: The bag is no longer available. The help, as soon as he dumped the flux, burned the bag, out here. We do have the flux.

"By Mr. Oberlin: Save that flux, and divide it into two portions substantially equal, and we will instruct you as to the delivery of one of them to plaintiff's counsel, retaining the other.

"By Mr. Quigley: All right, sir.

"By Mr. Oberlin: How much wire do you want, Mr. Wolfe? We will give you a whole roll if you want to order it.

1581 "By Mr. Wolfe: About a foot of it.

"By Mr. Oberlin: In addition to the exhibit marks, which have been placed by Mr. Wolfe on Exhibits 1-A and 1-B through 6-A and 6-B, I think there should be an additional mark, possibly a Graver mark, so that everyone will know these are the same plates, both for your protection and ours.

"By Mr. Wolfe: I suggest an adjournment for lunch."

Then we go to the remaining portion of Mr. Quigley's deposition, which was taken or continued on July 31st, 1946:

"By Mr. Wolfe", examining the witness, and this is starting on page 184:

"Mr. Quigley, when you put on the demonstration of the Lincolnweld process for us at the Graver plant, you remember, of course, that we took moving pictures at that time of the demonstration?

"A. Yes.

"Q. We have the prints of that movie film here. It is in two reels, and I am going to ask the reporter to mark those respectively for identification as Plaintiff's
1582 Exhibits 68-A and 68-B.

"(The reels of film referred to were marked Plaintiff's Exhibits 69-A for identification and 68-B for identification, respectively.)

"By Mr. Wolfe:

"Q. (Continuing) We have arranged that we can have a projector here to run them off, and I want you to see them. In advance of that, I wanted to tell you of some

questions that I am going to ask you about them afterwards, so that you can make whatever particular observation you want to of the movies, to be prepared to answer them. If you want to see them again, or some portion of them again, you are perfectly free to do so.

"The first point is that you will find that these movies show what amounts to a second set of welding on each size of plates. You recall that when you put on the demonstration, you had two sets of 1/2-inch plates which were marked as 1 and 2 respectively, and then you had two sets of 3/4-inch plate, and those were marked 3 and 4, respectively, and then you had two sets of 1-inch plate, and those were marked 5 and 6, respectively.

"Do you remember that?

"A. Yes.

"Q. In the movies, they will show the welding of plates 2, 4 and 6, in other words, the second one of each group, and you can check it to be sure that is accurate.

"More important, the two main questions that I want you to be able to answer for me when you come back up after we see the movies are, first of all, whether or not these movies accurately and faithfully show the procedure as it was demonstrated out at the plant. And, secondly, be prepared to tell me how that demonstration, as it appears in the movies, compares with the operation as you use it in your regular commercial production on plates of comparable size, or the same size.

"Is that clear?

"A. Yes, sir.

"By Mr. Wolfe: I think we might go down.

"By Mr. Oberlin: Were there any other movies taken then of the welding of these particular plates identified as Plates 2, 4 and 6?

"By Mr. Wolfe: No, there was none other taken. That represents the entire footage of movies taken out there.

"By Mr. Oberlin: I think it proper to make of record the fact that counsel for defendants, in the persons of Mr. Byron and myself, and in addition Mr. Yeomans, representing defendants, were shown these two runs of movie film on a previous occasion some weeks ago. The original movies were taken with a larger size film than the prints: is that correct?

"By Mr. Wolfe: Yes, I believe that is correct.

"By Mr. Oberlin: It should be a matter of record just

how the movies were taken, and what these prints
1585 constitute.

"By Mr. Wolfe: I understand that the original film was a 35 millimeter film, and these prints were printed on the smaller 16 millimeter film for use in the smaller and more available projectors.

"By Mr. Oberlin: I think inquiry was made by letter, and no reply yet received, as to whether a duplicate set of these prints which you are about to exhibit would be furnished to or be obtainable by defendants' counsel.

"By Mr. Wolfe: Yes. You may not have had an answer yet. If you have not, it is because my secretary has not gotten it written, but I dictated it the other day, and of course it is to the effect that you are perfectly welcome to have whatever copies you want.

"The original film is in the hands of the photographic laboratory who took the movies, and they can furnish you with whatever movie you may want to order in the way of a copy.

"Are we all ready for the showing?

1586 "By Mr. Byron: Yes.

"By Mr. Stewart: I also should probably make it a matter of record that on the occasion of the previous exhibition of these films, or movies, as you call them, the same representatives of defendants were shown a set of still photographs, and were furnished a set thereof, which I understand constitutes a complete set of such photographs taken on the occasion of the demonstrations in question. Is that correct?

"By Mr. Wolfe: Yes, that is, and in that instance, I have the negatives of those photos, if you want any further copies.

"By Mr. Stewart: Thank you.

"(All parties present then proceeded to Room 1314, 230 North Michigan Avenue, where films were shown. The parties then return to the 18th floor, 230 North Michigan Avenue, where the taking of depositions was resumed, as follows:)

"By Mr. Wolfe:

"Q. Mr. Quigley, you have seen the movies, Exhibits 68-A and 68-B, have you?"

1587 "A. Yes, sir.

"By Mr. Wolfe: I will ask the reporter to read

those two questions, if he will, that I said I wanted you to answer after viewing the films.

"(Record read by the reporter, as follows:

"'Q. In the movies, they will show the welding of plates 2, 4 and 6, in other words, the second one of each group, and you can check it to be sure that it is accurate.')

"By Mr. Wolfe:

"Q. That was what was shown, was it not, plates 2, 4 and 6?

"A. I have no way of telling that, whether it was the first plate or the second plate.

"Q. It was a half-inch plat, and then the three-quarter, and then the one inch?

"A. Yes.

"By Mr. Wolfe: Will the reporter read the first of the two questions?

"(Record read as follows:

"'* * * first of all, whether or not these movies
1588 accurately and faithfully show the procedure as it was demonstrated out at the plant.')

"By the Witness: Yes, it is the same.

"By Mr. Wolfe: Will you read the other question?

"(Record read as follows:

"'And, secondly, be prepared to tell me how that demonstration, as it appears in the movies, compared with the operation as you use it in your regular commercial production on plates of comparable size, or the same size.')

"By the Witness: I would say it compares favorably.

"By Mr. Wolfe:

"Q. Is it precisely the same, or did you notice any difference?

"A. No, I did not see any difference."

Now I jump to page 196. I might say between pages 190 and 196 these photographs, still pictures, were identified.

Beginning now on page 196:

"Q. How does the showing in those photographs
1589 in that binder, 69, compare with the appearance of this process in your regular commercial production?

"A. It is the same.

"Q. In that question, and in the corresponding one as to the movies, I put it in the present tense. Would the same answer apply, or some different one, as to this process in

your regular commercial production, say a year ago? Has there been any any change in appearance since then?

"A. No, nothing fundamental.

"Q. You would make the same answer whether the question were asked to current production, as of today, or a year ago, or two years ago, would you?

"A. Yes.

"Q. What was the name of the welding operator who ran the machine during these tests and who appears in the movies, and at least some fragment of him in the still photographs?

"A. Michael Yatsko.

"Q. Will you spell that for the reporter, please?

1590 "A. Michael, Y-a-t-s-k-o.

"Q. Do you know where he lives?

"A. His home is in Burnham. I cannot give you the exact address.

"Q. How long has he been with your company?

"A. I do not believe I can answer you exactly, but it has been five or six years.

"Q. He is one of your regular welding operators on this machine that you demonstrated, is he?

"A. That is right.

"Q. How long has he been on that work?

"A. He has been on automatic welding, I would say, just about his full term of employment here. He may have been a helper for a short time on one of those machines, but most of his time has been spent with automatic welding.

"Q. What instructions did you give him for running the machine in this demonstration?

"A. Well, the only instructions that he had were as to the amperage and voltage and speeds that were given

1591 to you in the deposition at the plant, and he was given that on the spot.

"Q. Did you give him any preliminary instructions?

"A. No, there were no preliminary instructions at all, other than the fact that there would be a group out to see a demonstration.

"Q. What trial runs had you run on that setup?

"A. I think we ran one bead, that was all. That setup was made that morning before you fellows came out.

"Q. What did you run that on, what kind of plate?

"A. Oh, I don't remember. It was a piece of scrap.

"Q. Was this man one of your good operators that ran that machine on the demonstration?

"A. They are all good operators.

1592 "Q. How did it happen that you had to give him instructions as to current and voltage and speed?

"A. Well, you asked for a given amperage and voltage at the time on the job, and I just relayed that information that I gave you on to him.

"Q. Let us be straight about that. I did not ask for any voltages.

"A. No, you asked me what we were going to use.

"Q. And you made the choice?

"A. That is right.

"Q. You may remember that in your previous examination I asked you about an article that you had published at one time, which we marked for identification as Plaintiff's Exhibit 46, and its title is 'Procedure Control of Automatic Welding Processes', and at page 342 in that article is the statement, and I quote:

"'Perhaps more poor welds are due to ill-advised efforts on the part of the automatic welding machine operator to vary his specified procedure in an unsuccessful

1593 attempt to compensate for some variable in the fabrication or set up of the work, than to any other one reason.'

"In contrast to that statement, you testified at the conclusion of the examination, and I am reading at page 169 of the depositions:

"'We do not have any fixed data. We have had tables in the past that we have used when we were setting up procedures. However a good automatic job is largely due to a good operator. There are not any of these fellows that use a fixed table. Your operating conditions from day to day will change.'

"By Mr. Stewart: I object to that question, on the ground that you say that the one statement is in contrast to the other. I do not believe it is.

"By Mr. Wolfe: I will ask the witness if he can reconcile them.

"By the Witness: Yes, I think I can.

"By the Witness:

"A. At the time that article was written, automatic welding was not a general thing, and I think that people who were putting in automatic welding equipment

1594 were setting up their work very much the same as they would for manual operation. The point that was

being driven at was the fact that they should prepare plates correctly to get a certain result with an automatic machine. Now then, once you have accomplished that, you are going to have every day variations, everything does not come through exactly as you may hope, or as exactly as you may have the procedure set up, but, after a welding operator has had experience, he will automatically compensate for some of the things that come through.

"However, procedure is something where you set up a general rule and follow it as closely as you can, but that does not mean you hold everything right on the money, in a shop things do not come through that way.

"By Mr. Wolfe:

"Q. You no longer think you are most likely to run into trouble by difference from operating standards for current and voltage and speed, is that correct?

"By Mr. Stewart: I object to that. The quotation you read out of the article does not refer to voltage, current and speed.

1595 "By Mr. Wolfe:

"Q. Do you think that is likely to be a source of trouble?

"A. May I have the question again?

"Q. Do you think it is likely to be a source of trouble if your operators do not adhere to standards on voltage, current and speeds?

"A. It depends on the variation, naturally.

"Q. It is necessary to have some standard, is it?

"A. Oh, yes.

"Q. What degree of tolerance do you find permissible?

"A. Again, that would depend on the condition that you have on your job.

"Q. How did the depth of the layer of flux used in the demonstration welds compare with that you use in your regular commercial production?

"A. Very much the same.

"Q. What is done with the excess flux in your regular commercial production?

"A. We pick it off, screen it and reuse it.

"Q. What sort of goggles did the operators have on during this demonstration?

1596 "A. It was a green tinted goggle, a safety goggle.

"Q. For the preparation of the one-inch plates,

and I believe the ¾ inch plates, he put down a preliminary bead with a manual arc weld, didn't he?

"A. I cannot tell you just exactly which ones. I know there were plates, I think two plates, that he did put a manual weld on the back side.

"Q. And when he did that, he put on one of these regular welder's shields, didn't he?

"A. Yes. You mean, during the hand welding?

"Q. Yes.

"A. Yes.

"Q. Those goggles would not be safe to use for that purpose, would they?

"A. No, for a lot of reasons they would not.

"Q. Among others, he would be likely to get an eye-burn if he did it very long?

"A. That is true.

"Q. Did you examine the X-rays that were taken of the plates that were welded at the demonstration?

1597 "A. Yes.

"Q. And you examined the plates themselves, did you?

"A. Yes.

"Q. Or, I mean, the completed welds.

"A. Yes, on the six plates that we ran.

"Q. Did you find evidence of excessive penetration either from the plates themselves, or from the X-rays?

"A. From the X-rays of the plates themselves, you could not tell how much penetration there was.

"Q. Isn't it possible to judge penetration from an X-ray?

"A. Only if it was very obvious. By that I mean, if you did not have enough penetration so that the weld from one side did not meet the weld from the other side, you could see that was not enough penetration; but once they have come together, you cannot tell how much one bead overlaps the other, from looking at the outside of the plates, by looking at X-rays.

"Q. In any examination of the welds themselves, did you observe any excessive penetration?

1598 "A. By looking at the plates?

"Q. Yes. Did you take any sections of them?

"A. (The witness shook his head.)

"By Mr. Byron: Just a minute. You shook your head. You had better get the answer in.

"By the Witness: No.

"By Mr. Wolfe: Did you take any sections of the plates to examine that point?

"A. We looked at the sections when the plates were cut in half, before we shipped one half to you.

"Q. Did you find any evidences of any point of insufficient penetration?

"A. No.

"Q. What is the effect of voltage on penetration? By that I mean, if you change the voltage, does that have any effect on penetration?

"A. Yes, it does. The lower your voltage, the more penetration you get. The higher the voltage, it will run less. However, it takes quite a variation in voltage to show any great variation in depth of penetration.

1599 "Q. Other conditions being the same, a higher voltage will also make the operation wilder, that is, more spatter, and sparks, and arc flames, will it not?

"A. Not necessarily. If you went a way in excess, you would probably have a little bit more spatter than you might have for a short arc, or a normal running arc.

"Q. The thinner the amount of flux, the more of that same kind of wildness and fiery operation you will get, too, isn't that a fact?

"A. Yes, if you ran very low flux.

1600 "Q. So that if you want to make the operation look as wild as possible, the thing to do is to keep the flux as thin as you dare, and the voltage as high as you dare, is that right?

"A. That could be done.

"Q. Would there be any operating advantage in doing that?

"A. By 'operating advantage', what do you mean?

"Q. Would it make the conditions any more pleasant for the welder, or would it make a better weld?

"A. By going to extremes?

"Q. Yes.

"A. No.

"Q. There is not any advantage there by having the operation as fiery as possible?

"A. No.

"Q. In this demonstration, you could have made it less fiery by using more flux, could you not?

"A. I think that is a matter of economics. When
1601 you are welding commercially day by day, you do not use all of any one thing just to make things more comfortable.

"Q. In looking over those photographs, and the movie, I am not sure whether you attributed any significance to whether or not the appearance was fiery, or whether it was quiet, and no spatter, and so on. I want to be sure that your attention is directed to that part of the appearance. In your regular commercial practice of this welding process as you have carried it on over the past two or more years, have you commonly had such a display of fireworks as appears in those pictures?

"A. I do not think it was excessive.

"Q. You think that was normal for your operation?

"A. That is normal for our operation.

"Q. Who gave you your instructions for the demonstration?

"A. I had no instructions as to how. It was a matter of when. The instructions to me were to set up plates to
1602 weld as we would normally weld them, and the setup for the plates, as I have said before, was made between eight o'clock and the time that the group arrived.

"Q. Who gave you those instructions?

"A. The time?

"Q. And instructions you had.

"A. I think some of that was by letter from Cleveland. I would like to be refreshed on that, if that is possible, as to the time.

"Q. You can tell us your best recollection now.

"A. I think it was either Mr. Stewart or Mr. Van Duzer who wrote of the time that the demonstration was to be put on.

"Q. And did you talk to anyone about it prior to the demonstration itself, either the day or the day before?

"A. It was discussed, it was discussed that there was going to be a demonstration.

"Q. Did you get any further instructions then?

"A. No.

"By Mr. Wolfe: I think that is all of Mr. Quigley.

"Do you gentlemen have any questions?

1603 "By Mr. Oberlin: No cross-examination at this time. If the witness should be produced in open court at the time of trial, there may be questions at that time."

I move that this deposition be made of record in this case, as far as the parts which have been read are concerned.

That is all.

The Court: Is there any objection to that motion, other than what has already been made?

Mr. Cahill: None other than what has already been made, no, your Honor.

The Court: As to the portions that have been read, the motion is granted.

1607 Mr. Oberlin: If your Honor please, in response to the request as to the date of the license agreement from the National Tube Company to the Lincoln Electric Company, under the Robinoff Patent, I have ascertained by telephone—and I have not verified it further—that the date of that agreement is May 18, 1945.

Mr. Cahill: Thank you very much.

1608 Mr. Oberlin: We have also, I should state, with respect to the proposed demonstrations to be given by the Defendants this afternoon, furnished counsel for the Plaintiff with a list of the demonstrations that we expect to carry out; and if I may, I would like to hand the Court a copy of that list at this time.

We might have the list marked for identification as Defendants' Exhibit 119.

(Whereupon said list was marked Defendants' Exhibit No. 119 for identification.)

Mr. Oberlin: There will be further identification of it as the demonstrations proceed, although I should state, as I did yesterday to counsel, that these demonstrations will necessarily have to be given in the factory of the Defendant Graver Company, and not under the laboratory conditions that our opponents had at their disposal when they gave their demonstrations.

Therefore there will be perhaps a minimum of opportunity for asking questions as the demonstrations themselves proceed.

I assume, however, that we may have Reporters
1609 in attendance, or at least a Reporter, for such notes as counsel may want to have made of the statements.

1611 CHRISTIAN NUSBAUM, called as a witness on behalf of the defendants, having been duly sworn, testified as follows:

Direct Examination by Mr. Stewart.

Q. Doctor, will you give us your name, your ad-
1612 dress and your age?

A. Christian Nusbaum, 1580 Rydalmount Road, Cleveland Heights, Ohio.

Q. And where did you receive your preliminary education and then your graduate school education, and what degrees did you get?

A. I received both my Bachelor's and Master's degrees at Ohio State; and the degree of Doctor of Philosophy in Physics at Harvard University.

Q. When did you obtain your Doctor's degree in Physics at Harvard?

A. 1915.

Q. What did you do after that in your field?

A. For two years I was instructor in the department of physics at Harvard University, after which I became a member of the research staff of National Bureau of Standards at Washington.

Then two years later I became a member of the Division of Research at the Massachusetts Institute of Technology, after which I came to the Case School of Applied Science in Cleveland, Ohio, in 1923.

Q. Have you been with the Case School in the physics department ever since?

1613 A. I have been, first in the rank of assistant professor, then in the rank of professor.

Q. Are you a member of any technical societies?

A. I am a fellow of the American Physical Society; a member of the American Society for Metals; and also a member of the Cleveland Engineering Society.

Q. Have you done any industrial consulting, Doctor?

A. I have, in the field of X-rays, as well in other fields, with a variety of Cleveland organizations, as well as organizations outside of Cleveland.

Q. What type of organizations are those, Doctor?

A. I will mention one or two: Thompson Aircraft Products; Willard Storage Battery Company; Eaton Axle Company, or now called Eaton Manufacturing Company; Na

tional Carbon Company; McGlheen Chemical Company, and others.

Q. Now, Doctor, what does the field of physics include, in general terms?

A. In general terms it may be divided into six or more fields, mechanics, molecular, physics of heat, electricity, magnetism, light, sound and modern physics.

Q. Have you written any articles, without going
1614 into detail about them?

A. I have written several articles.

Q. Have you done experimental work in the field of X-rays?

A. The major portion of my time in the last fifteen years has been devoted to classroom instruction, both undergraduate and graduate work, in X-rays; to experimental supervision in the field of X-rays, both in what is known as diffraction and absorption of X-rays.

Q. Now, Doctor, have you seen the Lincolnweld electric arc-welding process in operation, commercially and in the laboratory?

A. I have at various times, in several organizations, commercial organizations.

Q. Will you state, Doctor, in your opinion whether an electric arc is used in the operation of the Lincolnweld process.

A. Well, the natural—from its conduct, knowing that an arc, when it is not submerged, that arc exists in the welding operation, it seems reasonable to presuppose that there is also an arc in welding, that is, in the submerged case, I mean.

Q. Have you made any investigation or experi-
1615 ments to determine the presence or absence of an electric arc—

A. I have.

Q. (Continuing.) —in the Lincolnweld process, when it does not appear to be visible?

A. I have.

Q. What type of experiment did you make?

A. The X-ray has the peculiar property or the distinguishing property of making things visible which cannot be ordinarily seen by the naked eye, that is, of locating one object within another object, and giving you some idea of the state and condition of that material which is not directly visible.

Q. Well, now, Doctor, to explain the manner in which

X-rays are used and the manner in which you made your experiments, did you prepare a chart?

A. Yes. I think I have my own.

Q. The question is, did you prepare a chart, Doctor?

A. I did prepare a chart.

1616 Mr. Stewart: Will you mark this for identification as Defendants' Exhibit 120, please.

(Whereupon said document was marked Defendants' Exhibit 120 for identification.)

By Mr. Stewart:

Q. Doctor, will you explain to the Court first Figure 4 of that chart, and thereafter the other figures as to just what they represent?

A. I should like to preface my explanation by a few remarks, if I may.

Q. Go right ahead, Doctor.

A. X-rays and light rays have certain properties in common. They are both what is known in scientific language as electro-magnetic waves. They both affect a photographic film. When light rays are allowed to fall on a photographic film, chemical action takes place. When X-rays are allowed to fall on a photographic film, the action on the photographic film in both cases is identical. That is, the nature of the chemical reaction which takes place in both cases is exactly identical.

There is one property, however, which is markedly different in the two types of rays. Light rays are readily absorbed by ordinary matter. They are trans-
1617 mitted only by substances which are transparent, such as glass or water.

X-rays, on the other hand, on account of their extremely short wave length can penetrate and pass through material of high density and of considerable thickness. X-rays can be produced which will readily penetrate through four inches of steel, as I shall illustrate later on.

The wave length of X-rays are from one thousandth to one fifty-thousandth of the wave lengths of light rays; that is, shorter by that amount, or by that many fold, rather. It is due to this exceedingly short wave length X-rays are capable of penetrating opaque matter.

Penetration also depends on the density of the body which is penetrated. A body of light density is much more readily passed through than a body of high density. In other words, a large amount of X-rays will pass through

aluminum than a corresponding sheet of equal thickness of iron or lead. I can illustrate that in Figure 4 of the available chart.

In the upper portion of the chart we have a body of high density. It might be steel, or even lead. Back of it is placed a photographic plate. The X-rays
1618 will be much less intense after having passed through the plate, than they were initially.

The effect on the photographic film will only be very slight; there will only be a slight darkening, and it may not be even an appreciable darkening of the photographic film.

I have designated those two properties as a body of high density; and on the film, what we call low photographic density, or light in appearance.

Below, in the same picture, we have a body of low density, which might be aluminum. The change in intensity of the X-ray beam will be very small. That is, the X-rays that pass through the body of low density are still of comparatively high intensity, although not as intense as they were initially.

The effect on the photographic film will be to produce a high degree of blackening, ordinarily known as high photographic density.

I should like to stress this, that a beam of low intensity, when falling on a photographic plate—pardon me. What was my statement, again? Did I say "a beam of high intensity"?

(The latter part of the answer was read by the Reporter.)

1619 The Witness: (Continuing) A beam of low intensity, when falling on a photographic plate, will produce a light effect on the photographic film.

An X-ray beam of high intensity will produce an intense blackening on the photographic film.

Now, to recapitulate, when an X-ray beam passes through two bodies, one of which has a high intensity—or rather, a high density, and the other, a low density, if the bodies are of comparable thickness, or of the same thickness, the effect on the photographic film in the first case will be very slight, while in the second case, it will be very marked.

Q. Now, Doctor, let me interrupt you right there, if I may.

A. Yes.

Q. Is the application of X-ray mechanism, and the mak-

ing of X-ray films, used commercially to determine the density and physical properties inside of steel?

A. It is very extensively used, yes, sir, and in many commercial organizations, such as the Aluminum Company of America, Thompson AirCraft Products, and many others, hundreds of such pictures are taken every day, to detect flaws and inclusions of various kinds.

If you have a steel plate which is slightly porous, when the X-ray beam passes through the plate, the presence
1620 of the porosity will be indicated on the photographic plate by a darkening of the film, corresponding to the position in which that porosity is located.

Q. And when you refer to "porosity", would it be fair to say—

A. That is, I mean the region of the plate which is occupied by air, or by a material of lower density than the metal itself, the surrounding metal itself.

1621 It might be a flaw, a mere crack, or it might be an inclusion of some kind, or merely a seam.

Q. Now, Doctor, will you please explain the physical setup which you used for taking X-ray pictures during a welding operation with the Lincolnweld process?

A. Do you mean, the experimental setup?

Q. Yes, the experimental setup which you used, and you may use your diagram to illustrate.

A. In Figure 1, X represents the target of the X-ray tube, the source of the X-rays.

The letter P designates two plates, which are mounted face to face on a common axle, S.

Q. And what was the general shape of those plates, Doctor? This is a side view, I take it; is that correct?

A. No, sir, this is an end view.

Q. An end view?

A. Yes, sir. A side view, really, is given in Figure 2.

The plates were of circular shape; that is, the plates were two circular plates, with a common face between them, mounted on the same shafting, or axle, S.

1622 This axle is capable of rotation at any definite speed.

E is the electrode, which is to serve as the positive terminal in the welding operation.

At the edge of the plates are two magnesium disks which serve as a container for the flux.

On a larger scale Figure 3 represents exactly the same arrangement of apparatus in larger detail.

E is the electrode or the positive terminal. P-P are the two plates. M is the magnesium shields which, along with the edge of the plates, serve as a holder for the flux.

In actual operation the current, the electrical current, passes from the electrode E—that is, the electrical current, to the plates P. I might call attention to the fact that back of the plates on the opposite side of the tube a photographic film is placed, wrapped in black paper so that the light will have no effect on the photographic film, and whatever effects are produced on the photographic film are produced by the X-rays.

Q. Now, Doctor, what would be the relative densities so far as the passage of X-rays through them,
1623 as between the plates, the electrode, the magnesium side walls and the flux?

A. To begin with the plates are of such thickness so that all the X-rays are practically absorbed. That is, the thickness for the time of exposure that we used in such that not any of the X-rays go through the two plates.

Q. What effect would that have on the film?

A. That would mean that that particular part of the film would not be acted upon at all by the X-rays and on development would be perfectly clear.

Q. Will you continue as to the other elements, Dr. Nusbaum?

A. The electrode absorbs approximately eight times as much as an equivalent path through the flux. On the film, therefore, the next thing in lightness would be the effect produced by an X-ray beam which has passed through the flux, the electrode, the flux, and then struck the film. That would be the next in lightness, or we would expect it to be.

Q. What about the magnesium plates, Doctor? Do they go through them?

A. All X-rays go through the magnesium plates, and therefore as a net result they will check out as
1624 far as any analysis is concerned.

Q. In other words, they are of uniform thickness?

A. Common to all paths.

Q. Right. Continue, Doctor.

A. As already stated, the flux is much less absorbent so that the X-rays after having passed through the flux will still have a fairly high intensity, and, where those beams strike the plate, the plate will be darker than any of the two preceding cases.

Q. Doctor, after you took X-rays with this apparatus

what did you conclude as to the area between the end of the electrode and the plates as to its relative density compared with the flux or the rod or anything else there with which you could compare it?

A. Since the X-rays which have passed through the arc produced an effect on the film which is the darkest on the film, it would indicate that the X-rays on emergence through the arc proper have the greatest intensity, and therefore have been absorbed the least.

You can only conclude from that, that the region of the arc is made up of material which is even less in
1625 density, physical density, of course, than the flux itself.

Q. Would that be true whether the flux was in granular form or in molten form?

A. If the flux in the arc zone were only in the molten form, and if it were the only substance that is present in the zone, then that region of the film would be lighter than the region which represents that of the flux, of the granular flux.

Q. Now, Doctor, after your experiments with X-rays was there any question in your mind as to whether the area between the electrode and the plates was occupied by a pool of molten flux or whether it was occupied by an electric arc?

A. The evidence indicates that a large portion of the volume of material between the electrode and the plate is in the form of a vapor, and thus in the form of an arc.

1626 Q. Now, Doctor, do you have with you the photographs or the films which you took in your experiments?

A. Might I just make one or two additional remarks?

Q. Go right ahead.

A. In actual operation, the electrode is kept stationary, because the time of exposure is approximately—is either one second or two seconds. The effect on the photographic film if the electrode were in motion would be to give you an extended picture of the electrode. We keep the electrode stationary; therefore it gives you a sharp and defined picture.

We also keep the position of the arc stationary. We do, however, rotate the work material, that is, the steel plates which are being welded together at their common edge, and the rate of rotation chosen is such as to represent normal working conditions, that is, 9 inches per minute for this

particular dimension of electrode and for the particular values of the current and voltage which were applied.

Q. Did you use the same size electrode in all your pictures, Doctor?

A. All conditions, with the exception of those definitely stated on the films, were the same.

As a matter of fact, on the envelope which contains
1627 the film all the conditions of the experiment are definitely and explicitly stated.

Q. What currents did you use, Doctor?

A. In all cases we used 400 amperes and 28 volts.

Q. Why did you not use any higher current?

A. There is a definite limitation to the energy that could be used in the laboratory in which the pictures were taken.

Q. Where was that laboratory? Whose laboratory was it?

A. The laboratory was that of the Herron Testing Company in Cleveland, Ohio.

Mr. Stewart: Can we set up the light box, your Honor?

The Court: Yes.

(And thereupon the shadow box was set up.)

By Mr. Stewart:

Q. What is the first film you have there, Doctor?

A. This first film was taken simply by way of explanation, or so as to aid us in the explanations of the films which are to be interpreted later.

They represent the electrode (indicating); and this is a shadow cast by the base plate.

Notice the gradation in lightness, from complete darkness to an area which is slightly less light.

1628 Next in gradation is the flux. That means the X-rays which have passed through the plate, are infinitely small. It is somewhat larger, the intensity of the X-rays, after having passed through the flux.

The intensity of the X-rays is slightly greater after they have passed through the flux; that is, less has been absorbed.

At the bottom of the electrode, a small piece of cotton was interposed. Cotton has a very light density, and therefore absorbs very little, or only to a very small degree.

The X-rays which have passed through the flux, through the cotton, and through the flux on the other side, have been much less absorbed, or are much more intense, than

the X-rays which have passed through the flux itself; and that is indicated by the darkness on the film.

That gives you an idea of the dimensions of the cotton sample.

If, in this place, (indicating) we had placed an object, such as lead, which is more dense than steel, its presence would have been indicated by a very light region, lighter, even than that of the electrode itself. It would have
1629 been perfectly clear if it had been an object of high density.

In the next film—

Q. Dr. Nusbaum, would you please hand me each time the film and envelope in which it belongs?

A. All right, sir. There is no envelope for this one.

Q. There is no envelope for that?

A. No, sir. It is really not a member of the series proper.

Q. All right.

A. Or rather, I should say, it is really not a part of the series proper.

Q. It is only illustrative?

A. Yes, just illustrative.

Q. All right.

A. Radiograph 1: No flux used; rate of travel 9 inches per minute; welding procedure, 400 amperes, 28 volts; film-to-target distance—that is, the distance between the target of the tube and the X-ray film, 24 inches; 185,000 volts applied to the tube; 5 milliamperes; exposure time 1 second; type of film, A-slow.

Mr. Stewart: For convenience, your Honor, may we have these all in series, and give them their numbers as we go along, and then have the Reporter put the num-
1630 bers on them afterward.

The Court: Is there any objection to that procedure?

Mr. Wolfe: No objection.

By Mr. Stewart:

Q. You may continue.

A. (Continuing) The lightest region, again, is the shadow cast by the base plate. All of the rays are absorbed.

The next in intensity is the X-ray beam which has passed through the electrode, and in this case only through the electrode—that is, the magnesium plate and the electrode.

Right here (indicating) is a region which constitutes the arc. That region is definitely darker than that of the elec-

trode itself. Since it is darker, that means that the region is less absorbent to the X-rays, and therefore the X-ray beam which hits the plate, is more intense.

We know that, in the open arc, the current is transferred by the mechanism of what we call an arc mechanism.

I desire to stress again that this is the darkest region on the film, as far as we are concerned.

1631 This region back here (indicating) is produced by X-rays which have passed only through the magnesium holder, and therefore are very little absorbed. This (indicating) is the height of the magnesium holder. This (indicating) is the portion of the film which has received the entire intensity of the X-ray beam. This has received the entire intensity; and this (indicating) not any at all.

There is an extreme gradation there from the perfectly clear film, to the perfectly dark film. That darkening is produced by the magnesium plate.

(Film II placed on the shadow box.)

The conditions are the same as in the preceding case, except in this case we are using flux. The depth of the flux is 1 1/2 inches; rate of travel 9 inches per minute; amperes 400; volts 28; film-to-target distance in this case, 18 inches. The voltage and the amperage for the tubes are the same, but we are using a film which is more sensitive, and therefore enables us to take the picture in a minimum short interval of time. The exposure time was one second. Type of film, K-fast.

This (indicating) represents again the base plate; the electrode; the flux; and the arc zone.

1632 By Mr. Stewart:

Q. For the record, Doctor, will you indicate where that arc zone is, as between what things?

A. The arc zone is located directly between the end of the electrode and the material which is being deposited.

Q. You said the end of the arc, Doctor.

A. I beg your pardon?

Q. You said the end of the arc. I think you meant the end of the electrode.

A. Yes. Between the end of the electrode and the portion of the plate at which the material is being deposited. This (indicating) represents—

Q. That is, indicating a raised portion in the surface of the plate.

A. (Continuing) —the welded material along with the

flux which has been deposited. The direction of travel is counter-clockwise. That is, as you are looking at it, from right to left. The plate travels in this direction (indicating) and the weld is being continually deposited at this point.

The arc zone is again darkest. It is darker than the region of the flux, which means that the over-all
1633 density in the arc zone is less than the physical density of the flux itself, which can only be explained by the presence of a large amount of vapor in the arc zone.

(Film III placed on the shadow box.)

This radiograph was taken under identical conditions as that of radiograph II, except for one thing: depth of flux. In this case the depth of the flux is approximately one inch, while in film II or radiograph II it had been one and a half inches.

The same properties which characterized the other film again characterize this film. The region of the largest or the greatest density of X-rays which strike the film is the region of the arc zone indicating again that that is the region of least density of the path of the X-rays, and can only be explained in a manner as already stated.

(Film III-2 placed on the shadow box.)

The only condition which has been changed, again, is depth of flux. This is radiograph No. III 2.

Q. That is Roman Numeral III.

A. That is wrong. The only conditions which have been changed are—the only condition which has been changed is the time of exposure. The time of exposure is two seconds in this case, instead of one second as in the preceding one.

1634 That means that the over-all effect of the film will, in this case, be a greater darkening all over. There may be somewhat less contrast, therefore, between extreme light and extreme dark; but again the arc zone is definitely indicated by a dark region on the film, and only the conclusions which have already been stated can be reached.

Q. What number is that, Doctor, for the record, that you are taking now? Give the number that appears there.

A. This is radiograph IV-2. Lincoln flux, depth of flux, one-half inch, rate of travel nine inches per minute, amperes 400, volts 28, film target distance 18 inches, kilo volts, 158, milliamperes 5; exposure time two seconds, type of film K fast.

Exactly the same qualities characterized this film as have characterized the preceding.

This region again is definitely darker and definitely defines the outline of the arc zone.

Q. The region you pointed to, Doctor, for the record purposes, was between what parts?

A. Between the end of the electrode and the portion of the work material at which the metal is being
1635 deposited. The end of the electrode is clearly and sharply defined. Not only in this radiograph, but in all the radiographs, the end of the electrode is clearly and sharply defined.

Radiograph No. VI: no flux; electrode is stationary; amperes 400; volts 28; film target distance 24 inches; kilovolts 185; milliamperes 5; exposure time one second; type of film A slow.

The electrode is stationary, and we are building up the materials. That is, I should say, the work material is stationary, and everything is stationary in this case, and we are building up the metal down below here.

The base plate or the work material again is represented on the film by the least optical density.

The next optical density is the electrode itself.

No flux, again, is present. This darkening is, therefore, produced by the X-ray beams which have passed through the magnesium shields.

There is a definitely marked dark region between the end of the electrode and the metal being deposited.
1636 Q. Doctor, interrupting there, is that an X-ray picture of a completely open arc with no flux or no coating on the rod?

A. This is a picture of an electrode at rest, an open arc, and no fluxing material is present, either on the rod or surrounding the rod.

Radiograph No. VII-2: Lincoln flux, one and one-half inches; electrode stationary—electrode and work material stationary. Other conditions are the same as in the preceding film.

The light area represents the metal which is being melted or the molten metal solidified which is being built up.

Here is the flux (indicating), the electrode, and the darkest region again is the arc zone in this case.

Q. Doctor, can you indicate the space there above the end of the electrode and tell what that represents?

A. Above the end here (Indicating)?

Q. No, above this tip there is a space between the end of the electrode and what you have described as the metal which was deposited, also the darkened area which
1637 appears around the electrode, the end of the electrode.

A. The end of the electrode is sharp, defined. The space between the electrode and the material deposited, as well as a portion of the material further on up the electrode, is definitely darker than any of the surrounding flux.

Q. What does that indicate about the area up above the end of the electrode?

A. That that is present in the form in which a large portion of the material is, in the form of vapor that is vaporized.

Mr. Stewart: Your Honor, I offer the X-ray films which are enclosed in paper envelopes in which the data described by Dr. Nusbaum is typewritten, as Defendants' Exhibits 121 and 121-A, 121-B, 121-C, 121-D, 121-E, 121-F and 121-G.

Mr. Wolfe: No objection.

The Court: They are admitted.

(Whereupon the said X-rays were marked DEFENDANTS' EXHIBITS 121 and 121-A to G, both inclusive, and admitted in evidence.)

1638 By Mr. Stewart:

Q. Now, Dr. Nusbaum, in the field of physics, which I assume includes electronics, ionics, and so forth, what is meant by the terms "conductivity" and "resistivity"?

A. Conductivity means the conductance of a centimeter cube of any given substance. Resistivity means the resistance of a centimeter cube of any given or specified substance.

Q. That is, the electrical conductivity?

A. Electrical conductivity.

Q. And electrical resistivity?

A. That is right.

Q. I am confining my questions to that. We are not talking about thermal conductivity or thermal resistivity.

A. No, sir.

Q. Doctor, what is the relationship between conductivity and resistivity in the field of electric current, or the use of electric current?

A. Conductivity is defined as the reciprocal of resistivity. That is, the conductivity is equal to one divided

by the resistance. That means that whenever the con-
1639 ductivity is low, the resistivity is high, and whenever the resistivity is—and whenever the conductivity is—will you read that back to me, please. I am confused.

(The record was read as follows: "A. Conductivity is defined as the reciprocal of resistivity. That is, the conductivity is equal to one divided by the resistance.")

The Witness: I meant "resistivity" instead of "resistance."

(The answer was further read, as follows:

"That means that whenever the conductivity is low, the resistivity is high"—)

The Witness: (Continuing) —and whenever the conductivity is high the resistivity is low.

1640 Q. Well now, doctor, if you multiply the resistivity of a given substance by its conductivity, what do you always get?

A. By definition, the product of conductivity to resistivity is always equal to unity.

Q. And by "unity" you mean what?

A. One.

Q. One.

A. Yes, sir, it is always equal to one.

Q. So that, using the illustration of a teeter-totter, if you have resistivity sitting on one end of the teeter-totter, and conductivity sitting on the other end, and they are equal, they will stay the same; that is correct, is it not?

A. Yes.

Q. On the other hand, if you reduce the one, the other must go up; is that correct?

A. Yes, sir, that is correct; if you lower the one, you automatically raise the other.

Q. Yes. Now, as between solids, confining solids to metals, and liquids, confining liquids to fused salts, such as fused silicates, and gases or vapors:

Will you please state in general terms the relative conductivity and the relative resistivity.

1641 The Court: May I hear that question again, please, Mr. Reporter.

(Question read.)

Mr. Stewart: I want it clearly understood in my question there, if your Honor please, that there are three categories; in the first category, the solids, confining solids to metals; in the second category, liquids, confining the

liquids to fused salts, such as fused silicate; and in the third category, gases, or vapors.

The Witness: The resistivity of all of the metals is very low.

By Mr. Stewart:

Q. And what does that mean so far as their ability to conduct current is concerned?

A. That they very readily conduct an electric current; or, another way of saying the equivalent thing is, for any given potential—

Q. And when you refer to "potential" you mean voltage, do you, Doctor?

A. Yes.

Q. Continue.

A. (Continuing) —For any given voltage, applied to the conductor, the current is of a high order of magnitude.

1642 Q. So that in a welding operation, the current going through the electrode, the steel electrode, with the given voltage, can be very high; is that correct?

A. Yes, sir, that is correct, and without unduly heating the electrode.

Q. And it does not unduly heat the electrode because the conductivity of the electrode is high, but the resistivity is low; is that correct?

A. Correct.

Q. Now will you please discuss in general terms, Doctor, the same situation regarding the transmission of electric current fused salts,—and fused salts include fused silicates, do they not?

A. The mechanism of current transfer in conductors, is entirely electronic.

Q. Do you mean, metallic conductors?

A. Didn't I say that?

Q. No, you did not have the word "metallic" in there, Doctor.

A. Well, the electrical transfer, or the transfer of electrical energy in conductors, is entirely—

Q. Pardon me again, Doctor; do you mean, metal conductors?

A. In metallic conductors, yes, I should say.

Q. Yes.

1643 A. (Continuing.) Is entirely electronic in nature. When a voltage is applied to a conductor, the electron

will immediately drift, or tend to move, through the conductor toward the oppositely charged electrode, or the positive electrode.

Q. That is, in a solid conductor?

A. Yes.

Q. Now, taking a fused substance, such as a fused silicate, or a fused salt:

What is the means of carrying or transmitting the current, compared with that in metals?

A. In a fused salt, the transfer of electrical energy takes place only by means of ions. The electrons play no role there.

An ion is an atom which has either gained or lost one electron. In the transfer of the electricity, then, these ions move through the body of the molten salt, the positively charged particles, or ions, toward the negative electrode, and the negatively charged ions towards the positive electrode.

Q. Now, Doctor, with respect to the relative speed of movement of these ions: is that confined to fairly definitely known limits?

1644 A. The speed with which the ions move is relatively small in order of magnitude of a few centimeters per second, per volt.

The velocity of the electrons, however, is of a much larger magnitude, thousands of times greater.

Q. The velocity of the electrons in a fused salt?

A. There are no free electrons in a fused salt.

Q. But, Doctor, you are comparing, are you not, for the purpose of clarity, the speed with which ions move in a fused salt, with the speed at which the electrons move—

A. In a metal.

Q. —in a metallic conductor?

A. Yes.

Q. That is correct, is it not?

A. Yes, sir.

Q. All right. Now, Doctor, what is the nature of the transmission of the current in the electric arc, as compared with the transmission of current in a fused salt?

A. It is also primarily electronic in nature, with the ions participating to a limited extent.

1645 By Mr. Stewart:

Q. And so far as the speed of movement is concerned, can you give us some comparison?

A. The speed of movement of the electrons in an arc depend directly on the voltage applied, and such speeds may be as great as 60,000 centimeters per second.

Q. As compared with, I believe you said, 7 centimeters per second in a fused salt?

A. As compared with a few centimeters motion of the ions in a fused salt.

Q. Now, Doctor—

A. May I add?

Q. Yes. Go ahead. If you are not finished.

A. The speed of the electrons in an arc, that is, the maximum speed of the electrons in an arc can be calculated on definitely known physical laws.

Q. Now, Doctor, considering the phenomenon of passing electric current through a molten or liquid medium, what is that medium called in physics?

1646 A. It is ordinarily known as an electrolyte or a fused electrolyte.

Q. So that if you could pass any amount of current through a molten pool of flux, that would be passing it through a fused electrolyte?

A. That is correct.

Q. And that is possible to do, is it not?

A. It is.

Q. Now, as to the amount of current—first, what is, in general terms, the resistivity of fused electrolytes as compared with the resistivity of the arc, the electric arc?

A. On account of the nature of the electric arc it is difficult to speak of it in terms of resistivity.

By Mr. Stewart:

Q. Can you speak of it in terms of conductivity, the reciprocal?

A. Just a second. It is generally spoken of as a negative resistance due to the fact that current
1647 increases, or with increase in current the voltage decreases. That is, the current continually tends to increase in magnitude after it has been started.

Q. Is that true of a fused electrolyte?

A. It is not.

Q. Now, as to the comparative conductivity—and by "conductivity" I mean the ability to transmit current through it—as to the comparative conductivity of a fused electrolyte and the electric arc, in what proportion can you describe them?

A. Using the term in a manner as designated, the conductivity of the electric arc is thousands of times greater than fused salts, in general.

Q. And does that include a fused salt?

A. That includes any fused salt.

Q. Now, Doctor, when you have current by ionic conduction in a fused salt and current transferred by ionic and electronic conduction in the arc, can you illustrate the relative mobilities of those current carriers, the ions and the electrons?

A. In ionic conduction, as an example, we may think of a group of men, a large group of men, in wading.

Q. How deep?

1648 A. Knee deep, if you want.

Q. All right, go ahead.

A. That one half of the group have a positive sign on them, and the other half of the group a negative sign, so as to differentiate the two groups. That these two groups are initially distributed at random.

At any given instance when the potential is applied, all the positive tend to move in the direction of the negative bank, because negative always attracts positive, and all the negatively charged individuals or designated individuals tend to move to the positive bank or side.

You have, therefore, a continual motion in opposite directions of these two oppositely designated individuals. In their motion they will collide and jostle each other, and also will experience considerable interference in their motion, on account of their wading through water of a definite depth in any given case.

Q. How do you compare that, that ionic mobility, with the ionic and electronic mobility in an arc?

A. As already stated, the speed with which an electron moves is very great, and it depends on the
1649 potential applied. The mass of an electron is also exceedingly small in comparison to the mass of an atom.

These fast-moving electrons, when they collide with an atom, cause the atom to lose one or more electrons, which then are in a position to conduct themselves exactly in a similar manner as the electron which was part of the collision.

After the collision, the electrons act as negatively charged particles, and add to this rapid motion of the electrons.

The atom, which is now positively charged, is then an ion, and it will begin to move in the opposite direction from which the electron itself is moving.

This process of producing electrons and ions from atoms is called ionization, and takes place at a tremendously high speed in a gas, causing the gas, the thus ionized gas, to become exceedingly highly conductive.

Q. And compared to the conductivity of a similar volume of fused salt, what is the relationship?

A. The conductivity of the ionized vapor may be thou-
sands of times greater than that of the corresponding
1650 conductivity of an equivalent volume of fused salt.

Q. Now, Doctor, consider for a moment the starting of an arc, when using a bare rod electrode, uncoated rod. What happens when you first touch the electrode to the weld piece, when the current has already been applied?

A. Beg pardon?

Q. When the current has already been applied, what happens when you first touch the tip of the bare rod electrode, no flux, against the other electrode?

A. You mean when the voltage has already been applied?

Q. Yes.

A. There is no current flowing, but the voltage is already applied?

Q. Yes.

A. You may have difficulty in making a good contact between the metal electrode and the work material. Assuming that you are able to establish adequate contact—

Q. By "contact" you mean electrical contact—

A. Electrical contact.

1651 Q. —and not physical?

A. Well, it is physical contact, also.

Q. All right. Proceed.

A. If proper contact is once established, a current immediately begins to flow. The energy developed is of sufficient magnitude to cause some of the electrodes at the point of contact to be fused.

The current increases still further, and in the process of being heated, vapor is produced. This vapor immediately becomes ionized, and the current then increases very rapidly in magnitude.

The magnitude of the current which may be attained will depend upon the kind of electrode and also upon the

conditions of the current, the electrical conditions of the current.

I may say that this phenomenon which I have described—the contact, the fusing of the metal, vaporization and ionization—takes place in succession and continuously in an exceedingly small fraction of a second, perhaps a hundredth or a few hundredths of a second; and it is a phenomenon which is always experienced when the electrical line or system is short-circuited.

1652 The flash which is observed is an arc, and the transmission of the electricity is by means of an ionized gas or vapor.

1653 Q. Now, when you weld, Doctor, once you have established that arc, with a bare rod, and keep moving it along the plate, what is it that melts, or generates the heat to melt, the electrode and the parent metal? What provides the heating means?

A. The heat that is developed depends entirely on the voltage that is applied, and the current that is transmitted, and is always equal to the product of the two quantities. That quantity of energy is generally expressed in watts, or as watts. As an example, for a current of 400 amperes, 28 volts, the power is developed—or rather, I should say, the energy developed per second will be equal to the product of 400 times 28, which is 11,200 watts.

We can readily determine the release of energy by dividing that quantity by a number which is approximately equal to four; so in this case we have about 2800 calories developed every second in the arc.

Q. And the release of that quantity, or that number of calories per second, is responsible for the melting of the rod and the plates; is that correct?

A. It is, yes, sir.

1654 Q. Now, Doctor, is there any different phenomenon takes place, so far as the transfer of current, the generation of heat, and the melting of the rod and the plate are concerned, when you use a coated electrode in hand arc welding?

A. There is no difference in the mechanism of heat generation, no, sir, or if there is, it is only to a very, very limited extent.

In both cases the heat is generated by the electronic and the ionic stream. The energy inherent in the arc itself is really the kinetic energy of motion of the electrons and the ions.

The electrons move at a terrific speed.

Q. Now, Doctor, in open arc hand welding, will you please explain what is known as the crater in the plate?

A. If the plate is a negative electrode, you will observe at the plate, it is generally known as an arc cavity, and this cavity, or depression, is believed by many to be due to the impact of the ions, in this case iron, upon the molten metal.

Q. And what does that look like, Doctor? Is there any analogy that you can draw as between the ions in the arc stream, and their velocity against the plate, and any other phenomenon, some simple one, such as a hose, or
1655 anything of that sort?

A. Yes, sir, it is exactly analogous to the case, or it is similar to the case, if an individual should take a hose, and by means of the hose, play a stream of water upon the surface of water in a pool.

At the point where the stream of water from the hose hits the surface of the water in the pool, there would be a depression produced, due to the impact of the molecules—or rather, due to the impact of the parts of the moving stream of water.

1656 Q. Now, Doctor, when you come to automatic welding with the bare electrode under a deep layer of flux, what happens when the electrode is fed down and touches the plate, the potential on and the current being on, just the same as in the hand electrode? What takes place?

A. The mechanism of the process is exactly similar. You can start the flow of current by improving the contact, as is often done, by means of steel wool.

However, after the current is started, it will not only fuse the steel wool, but portions of the electrode. There is a sudden rise in temperature, vapor is formed and the current is no longer transmitted, or only to a small extent, by the fused material of the electrode; but by the vapor which has been produced, and by "vapor" I mean the ionized vapor which has been produced.

There may be present, and undoubtedly is present, on account of the tremendous amount of energy that is released, a certain amount of molten flux. That molten flux will be definitely limited to the exterior portions of the arc zone and cannot exist in the arc stream proper.

Q. Now, Doctor, in the automatic process under a
1657 deep bed of flux, what is it that melts the flux?

A. The heat in the arc zone, or in the arc stream.

proper, is dissipated in the following ways: by conduction to the electrode proper, as indicated by the fact that the electrode becomes very hot, even though it is not in the zone itself; by melting a portion of the base material; by transfer away from the base material, and then by conduction to the surrounding unmolten or granular flux.

Q. When you speak of conduction, is that thermal conduction or electrical?

A. That is thermal conduction and not electrical conduction. This transfer of heat from the arc zone proper to the surrounding flux melts the flux in the surrounding region.

Q. And throughout the entire welding operation with the Lincolnweld process under a deep bed of flux, does that same occurrence take place?

A. It must. You could not continue a welding operation without an arc being present, whether it is an open arc or a so-called submerged arc. The amount of energy that could be released by a molten flux could never be adequate to attain the purpose.

1658 Q. Doctor, when current is being passed through any medium and comes to a place where it has a choice of two paths, which path will it take so far as the conductivity of the paths are concerned?

A. An electrical current—if two or more paths are permissible, one being, we will say, highly conducting and the other poorly conducting, by far the largest part of the current will flow through the highly conducting material and a much smaller proportion of the current will flow through the low conducting material.

Q. And will that—

A. You could express—just a second, please.

Q. Go right ahead.

A. (Continuing) —this same relationship in terms of resistivities. If we know the resistance of either path—I mean, if we know the resistance of both paths, we can readily calculate what fractional part of the current will be carried by one and what part by the other.

Q. Now, as between the two choices of current in an electrode, assuming that electrode is immersed in molten flux, what porportion of the current will be carried by
1659 the arc stream and what proportion will be carried by the molten flux?

A. Assuming that after the operation is over, that

approximately equal masses of fused iron and fused salt, fused flux, have been deposited, the amount of current present or the amount of current transferred, I mean by the fused flux, is perhaps less than one thousandth of the current that is transferred by the arc.

I mean by that if the current transferred from the electrode to the work material is a thousand amperes, that not more than one ampere of that total current will be transferred by the flux, and 999 amperes will be transferred by the arc itself.

Q. All right, Dr. Nusbaum, in the Lincolnweld process, as you have studied it, experimented with it, is the current carried across the gap between the electrode and the plate by and through the molten flux?

A. The current that is carried from the electrode to the work material when Lincolnweld flux is used is insignificant, in comparison to the current which is carried by the arc.

Q. And does the current carried, the insignificant
1660 current that could be carried by the molten flux, as compared with the balance of the current carried by the arc, could that first insignificant amount be in any way responsible for the melting of the electrode or the plate?

A. Since the heat developed is proportional to the square of the current—a well established law in physics—the amount of heat developed by the current which flows through the flux would be most insignificant, as compared to the heat which is developed in the arc.

Q. In your opinion, during the welding operation, Doctor, is the flux melted by the heat generated by the current going through the flux, or is the flux melted by the heat generated by the arc?

A. The heat developed in the molten flux is insignificant, and the melting is due—the melting of the flux is due to the heat developed in the arc.

Q. Is it possible, Doctor, physically possible, to pass a current of the magnitude used in electric welding through a fused salt or molten flux and progressively melt the electrode and the plates without using an electric arc?

A. If you should attempt to pass a heavy current
1661 through a molten flux after a certain current density is attained, vapor is formed and an arc is established. The energy developed then will not be developed any longer by the flux, but will be developed by the arc.

Q. Doctor, what is meant by the term which is used

in this Jones patent, which you have read, "by a high resistance conductive salt"? What do those words mean?

A. The terms used are contradictory. We cannot have a high resistance conductive salt, because a conductive melt —we mean by a conductive melt that it is a melt which readily transfers electricity, and therefore its conduction is high and the resistance would be low.

Q. Doctor, handing you what has previously been introduced as Plaintiff's Exhibit 167, and calling your attention to the diagram in the upper right-hand corner, with the typewritten portion attached there entitled "Conduction of Electric Current", will you examine that for a moment, please.

1662 (The witness examined the exhibit.)

By Mr. Stewart:

Q. Have you read it, Doctor?

A. Not quite.

Q. Pardon me. Go right ahead, then.

A. I have now, yes, sir.

Q. All right.

A. Could I keep it?

Q. Yes.

A. Or do you want it?

Q. No, you may keep it.

Now what in your opinion, as a physicist, does that represent, so far as scientific possibility is concerned?

A. It is very highly imaginative, and I do believe—or I can state more definitely, I know that it does not represent scientific fact.

It is misrepresentative; it misrepresents.

Q. In what way?

A. They speak of a pool of flux, that the entire pool is ionized, that molecules are broken up into ions and free electrons.

1663 As has already been stated, in a molten salt free electrons do not exist, and that is a generally and in fact universally accepted fact.

In a molten salt the transfer is only by ions, and free electrons do not at any time participate.

Then a little farther down here it says that the core of the pool is of low density.

The impression is given that it is still molten material.

Q. When you say "a little farther down" Doctor, you are quoting from the chart, are you not?

A. Yes, sir.

Q. Yes.

A. "Core of pool of low density, probably made up of a swirling mixture of melt vapor and mist mixed with iron vapor and mist.

"Largest proportion of electric charges is borne by the more rapidly moving electrons."

The current that is carried by the electrons constitutes an arc, and no liquid substitute can persist indefinitely in the electric arc proper.

Besides, a liquid in an arc does not participate in the electrical transfer of energy, unless it is ionized, and a liquid metal is not ionized.

Q. Are you through with that, now, Doctor?

1664 A. Yes, sir.

By Mr. Stewart:

Q. In this diagram, as you have stated, it is indicated that—and I am reading—:

1665 "The largest portion of the electric charges (current) is borne by the more rapidly moving electrons in this core or inner portion of the pool."

What would you say about the relation of that proportion of current borne by what you have characterized as the arc, as opposed to any molten flux?

A. If a considerable portion of the current is carried by the molten flux and if the insulating material of which you speak is not melted, then there should be a definite change in the welding operation, because much less electrical energy could be transferred since no electrical energy could then be transferred by the molten flux.

Q. Actually what would you expect to take place, Doctor, if you used a coated electrode, so far as producing a normal welding action?

A. I would expect that the insulating material on the electrode would possibly extend beyond the electrode itself and that the operation would not be any different than it is in the case when there is no insulating material on the electrode itself,—

1666 A. (Continuing) —which would indicate definitely that there is no energy transfer or electrical transfer by the molten flux which is present.

Q. Would it be any different, Doctor, than welding with an open arc so far as the insulating material of the coating on that rod is concerned?

A. It would not be any different.

Mr. Stewart: That is all.

1668 *Cross-Examination by Mr. Wolfe.*

Q. Dr. Nusbaum, are you a member of the American Welding Society?

A. I am not.

Q. Have you ever been a member?

A. No.

Q. Have you published any books on welding?

A. I have not.

Q. Have you published any books on metallurgy?

A. I have not.

Q. Have you published any papers or reports on researches in connection with welding?

A. I have not.

Q. Have you ever conducted any researches on welding which were unpublished?

A. No.

Q. Have you ever done any manual welding?

A. I have not.

Q. When did you first see the Lincolnweld process?

A. At Thompson Aircraft Products.

Q. When?

A. Last year.

Q. Last year?

A. Yes, sir.

1670 Q. About a year ago, would you say?

A. Well, no, sir; it was less than that.

Q. And under what circumstances did you see it at that time?

A. Well—

Q. I mean, what was the occasion for your seeing it?

A. It was in more or less continuous use in certain operations.

Q. Did you go out there for the specific purpose of seeing it?

A. No.

Q. For how long a time did you see it out there?

A. Well, I saw it—I was engaged in other problems, and in going through their shops, I saw it from time to time.

Q. And what was the length of the intervals of observation?

A. Well, that would vary; perhaps on some occasions two weeks; and on other occasions possibly a month.

1671 Q. You mean those were the intervals between observations?

A. That is right.

Q. I mean, what was the length of individual observations?

A. Well, that may have varied from a few minutes to fifteen or more.

Q. And in what other plant or plants have you seen the Lincolnweld process in use?

A. Lincoln Electric Company.

Q. Any others?

A. No.

Q. At the Lincoln Electric Company, did you see the process being used in some regular commercial production project, or did you see it in the laboratory?

A. Saw it in the laboratory.

Q. And in regular production as well?

A. I don't recall, I don't think I did. I don't recall that I did.

Q. When did you first see it in the laboratory?

A. Perhaps three months ago.

Q. That was in connection with preparation for this suit?

1672 A. Yes, sir.

Q. And how many times did you see it in the laboratory?

A. Twice.

Q. The Lincoln engineers were there both times, I presume?

A. They were.

Q. So you observed it more or less under their tutelage at that time?

A. Not their tutelage.

Q. How much time did you spend on these two occasions in the Lincoln laboratory?

A. Perhaps half an hour on the first occasion; perhaps an hour on the second.

Q. Have you ever seen the Unionmelt process, prior to its demonstration in the course of this trial?

A. I don't believe I have.

Q. You have never seen it either in the laboratory or in commercial use?

A. Not in commercial use or in the laboratory.

Q. Were you present at the demonstrations that were made here by the plaintiff?

A. I was.

Q. Both of them?

1673 A. Yes. Well, what do you mean by both? There was only one demonstration, and that was the early part of—Friday of last week.

Q. And were you present on Monday of last week?

A. No, that wasn't Monday of last week. Let's see, when was it?

Q. The Court has been to the demonstration room on two separate occasions. What I want to know is if you were at both of them.

The Court: Here is a calendar, if you wish to refer to it.

The Witness: I think the demonstration, if I remember correctly, was either Tuesday morning or Wednesday morning—wait just a second; either Wednesday morning or Thursday morning, I don't recall which it was.

By Mr. Wolfe:

Q. But you were only over there once?

A. That is right.

Q. Have you made a thorough acquaintance with the scientific literature in the field of welding?

A. I have. All the information is based on physical principles.

1674 Q. And, as a part of your preparation for this case, have you made it a point to read a large number of articles and books dealing with welding specifically?

A. I have.

Q. Have you acquainted yourself with articles which purport to explain what takes place in the Lincolnweld process or Unionmelt process?

A. The explanation was not applied to any particular process.

Q. Have you found any articles in the scientific literature which do attempt to make such an explanation, as applied to these particular processes?

A. What are you referring to when you say "these processes"?

The Unionmelt process and the Lincolnweld process, or either.

Q. I have reference to the operation of either the Lincolnweld or Unionmelt processes?

Are you thoroughly acquainted with the basic phenomena and actions which take place in ordinary arc-welding?

A. I am.

Q. Let us take one of those items, for example the matter of how a metal is transferred from the
1675 rod to the plate in an ordinary open arc with a bare electrode.

Now, in such a situation it is possible to deposit metal overhead on a ceiling, is it not?

A. That is right.

Q. So that in that instance we can leave aside any effect of gravity, is that right?

A. That is right.

Q. And in such a case the metal goes from the rod to the ceiling in little droplets or particles, does it not?

A. It does, but they are not electrically charged.

Q. What is it that carries those droplets across from the rod to the ceiling?

A. That is not fully explained, by anyone.

Q. You do not know what it is?

A. It is not fully explained by anyone. But I would like to emphasize that the droplets themselves are not charged, electrically.

Q. In speaking of fused salts this morning, I believe that you said such materials, that is, in the fused condition, were ionized. Did I understand that correctly?

1676 A. Fused salts are ionized.

Q. An ion is the remainder of a molecule which has lost an electron or taken on an extra one, is it?

A. An ion is always an atom which has either gained or lost an electron. The positive ion has lost an electron. The negative ion is an atom which has gained an electron. It is negatively charged.

1677 Q. Now is it your opinion that in such a fused salt, there are no free electrons?

A. Yes, sir, it is, and there cannot be, from the very nature of the process.

Q. Are you familiar with Maxwell's law of distribution of molecular velocities?

A. Yes, sir.

Q. Is it not a fact that that law, or equation, applies in fused salts just as it does in ionized bases?

A. No, sir, it is not, because the velocities in fused salts are not enough to produce ionization by collision.

The Court: Are not enough to produce what?

The Witness: Ionization, by collision.

By Mr. Wolfe:

Q. You have considered that point carefully, have you, Doctor?

A. Yes.

Q. I mean, that is not just a spur-of-the-moment opinion?

1678 A. No, sir.

Q. Now, considering still further the fused salts that we were speaking of:

When an electric current is passed through them, their temperature increases, does it not?

A. Of the fused salts?

Q. Yes.

A. Yes, sir, it does—that is, the chances are it does, depending on the magnitude of the current, however.

Q. You can pass a sufficient current through so that the temperature will rise, can you not?

A. Yes.

Q. And with a rise in the temperature, the resistance decreases, does it not?

A. Generally.

Q. Or, as you put it this morning, the conductivity increases.

A. Yes.

Q. What tests if any have you made of the conductivity or resistivity of fused Lincoln flux?

A. None.

1679 Q. You have no experimental data, then?

A. Yes, I have.

Q. To present to the Court, on that?

A. Yes, I have experimental data.

Q. That you have taken yourself?

A. No.

Q. On Lincoln flux?

A. No.

Q. Do you have any data on the conductivity of this fused Lincoln flux at temperatures above 1,000 degrees Centigrade?

A. No, I have not—not on the Lincoln flux; but I have on magnesium silicate.

Q. Do your have any on conductivity above 1,500 degrees Centigrade?

A. This particular silicate that I am referring to now, is just below 1,500.

Q. And you have nothing higher than that?

A. No.

Q. Now, this morning you spoke frequently of arcs and an arc, and so on. As I listened to you, I did not note that you ever made any distinction as to any various kinds of arcs. You didn't attempt to draw any such distinction, did you?

1680 A. I was referring only to arcs of high current density.

Q. You, as a physicist, of course, know of a variety of arcs, do you not?

A. I do.

Q. And is it your testimony that in an arc there cannot be any liquid materials?

A. Not in the main current stream; not in the main arc stream.

Q. And of course, by "liquid material", you are including even finely divided particles that might normally be referred to as a mist?

A. That is right.

Q. In speaking of an arc this morning, you said, I believe that there was 100 per cent conversion of electric energy into heat energy. Did I understand that correctly?

A. That is right.

Q. And when a current, an electric current, passes through a fused electrolyte or salt, there is also a 100 per cent conversion of the electric energy into heat energy?

A. The electrical energy converted to heat is 100% at all voltages.

1681 Q. Have you ever seen any of this Lincoln flux made?

A. No, I haven't.

Q. You have never seen the electric furnace process that has been referred to, in which they make it?

A. No, I haven't.

Q. Have you ever seen any similar, generally similar material, electrolytes of any kind, melted in an electric furnace?

A. I have seen a metal molten in an electric furnace.

Q. You have never seen salts fused in an electric furnace?

A. I have in the laboratory.

Q. How high a current have you seen pass through a fused salt in such an operation?

A. I don't recall that the value of the current was observed.

Q. Is it, in your opinion, the kinetic energy of what you refer to as the arc stream that accounts for the heat developed in the arc you were speaking of?

A. The energy of the electric current is transformed into the kinetic energy of motion, or kinetic energy—

1682 energy of motion of the electrons and ions.

Q. How does that get into heat?

A. That is what we mean by heat, in this case.

Q. And do those rapidly moving ions and electrons,—are those what scores out this crater that you spoke of?

A. The ions do. The crater is formed by the ions.

Q. By the ions rather than the electrons?

A. The mass is larger; even though the velocity is less, they carry more momentum.

1683 Q. In fact, their mass is several thousand times as great?

A. Many thousands.

Q. Is the formation of a crater such as you mentioned an invariable accompaniment of an arc?

A. Yes.

Q. That is, whenever you have got this arc stream that you were speaking of in a high current arc—

A. That is right.

Q. (Continuing) —then you will always have a crater scoured out in the plate to which it is applied?

A. If the condition of the material, of the negative electrode, is such so as to produce that condition.

Q. If you had a piece of iron or steel plate that you were applying the arc to, then you would get a crater?

A. If the surface on which it strikes is a fluid one.

Q. Would iron plate or steel plate be a proper one?

A. If the surface has been molten and not yet solidified.

Q. Are you familiar with the term "arc blast"?

A. That is right. I have heard of it.

1684 Q. Is that related to the formation of the crater?

A. I think it is.

Q. And by "arc blast" you mean that measurable force which seems to be acting to separate the rod from the plate when the arc is going?

A. That is right. That is one of the evidences of it.

Q. Well, in acquainting yourself with the literature in the arc-welding field did you happen to come across the researches of Dr. Doan for which he was given the Lincoln Gold Medal, and in which he demonstrated that craters are oftentimes not formed when an arc is present?

A. That is possible.

Q. So that crater formation is not invariable accompaniment of an arc, is that right?

A. As I have already stated, it should be a function of the condition of the surface on which it strikes.

Q. Do you have any familiarity with his research in that direction at all?

A. I have not.

Q. Do you have any familiarity at all with his researches dealing with the lack of relation between arc blast

1685 and crater formation?

A. I have not.

Q. Is it not a fact that the crater of an arc may be changed radically depending upon the atmosphere in which it is constituted?

A. That is right, because the atmosphere may provide some of the material for the free electrons and the ions, as in the open arc or carbon arc.

Q. So that you may have quite a different—

Mr. Byron: Just a minute. Had you completed your answer?

The Court: I did not get the answer. Read it, please.

(The answer was read.)

The Witness: As in the open arc or carbon arc.

By Mr. Wolfe:

Q. And if you have exactly the same electrode, and the same plate, and the same voltage conditions, and you substitute some different atmosphere for air, you are likely to get an arc that will display entirely different characteristics from that which you have in air; is that not so?

1686 A. It may display different characteristics, yes, sir.

By Mr. Wolfe:

Q. And are those characteristics predictable by you as a physicist, upon being told what the atmosphere is which you substitute for air?

A. In some cases.

Q. In other cases not?

A. Not so readily.

Q. Well, in some cases not at all; is that not so, Doctor?

A. Right.

Q. Your X-rays which you presented this morning, or your radiographs, were, as I remember it, all taken either with Lincoln flux, or with no flux at all; is that correct?

A. Right.

Q. Have you made any, using Uniommelt?

A. No.

Q. Have you made any, using clay flux?

1687 A. I have taken some pictures using Robinoff flux.

By Mr. Wolfe:

Q. Do you have those here?

A. Yes.

Q. Could we see them, please?

A. Yes, sir.

(The witness handed certain films to counsel.)

By Mr. Wolfe:

Q. Are there several of them?

A. Two or three.

Mr. Wolfe: May we have them marked for identification, please, as Plaintiff's Exhibit—

1688 Mr. Becker: 229.

Mr. Wolfe: —229.

By Mr. Wolfe:

Q. Do you have some numbering on them, Doctor, so that we can key them to the exhibit number?

A. Yes—2-R.

Q. Let us have the jackets, please, and then we can keep them together.

A. What is the one you have there?

Q. 11-R.

A. No, that is Roman II-R.

Q. Oh, yes, II-R. Pardon me. Do you have any others?
A. Yes, sir, right here.
Q. You have handed me III-R, IV-R, VII-R and VIII-R, I believe; is that correct?
A. Yes, sir.
Mr. Wolfe: I will ask that these all be marked for identification serially.
(Whereupon the said pictures were marked Plaintiff's Exhibits 229-A, B, C, D, and E, respectively, for identification.)

1689 By Mr. Wolfe:

Q. Now, you have some notes there, Dr. Nusbaum, from which you can tell us the operating conditions under which each of these series was taken?
A. I don't believe I have with me.
The Court: Just a minute; I didn't hear the question.
(Question read.)
The Witness: For any given numeral number, they are the same—or Roman number, rather.
VII of the previous series would correspond with VII-R of this series; and whatever the voltage is for VII, the voltage would correspond to VII-R.
As a matter of fact, all voltages were 28 voltage and the amperage was 400 in all cases. They never varied.
Mr. Wolfe: Let's have the light box set up here. We want to look at some of those other X-rays.
(Whereupon the shadow box was set up.)

By Mr. Wolfe:

1690 Q. What was the size of the electrode that you used, Doctor, in making the X-rays that you presented this morning?
A. 5/32nds of an inch.
Q. What one was used with the clay flux?
A. All of them were 5/32nds of an inch.
Q. Now, this last series of X-rays which you have handed me here, you said, were made with a Robinoff flux, I believe.
A. That is right.
Q. Was that one that you prepared?
A. I know nothing—no. I know nothing of its preparation.
Q. Do you know whether or not that was the clay flux which the Plaintiff furnished to the Defendants?

A. I do not know.

Mr. Oberlin: I do not know offhand. I assume it was.

Mr. Stewart: It was intended to be.

Mr. Byron: I think that must be true, because we wanted to know ourselves.

By Mr. Wolfe:

Q. I am going to use your identification numbers there for a moment, Doctor.

A. Yes, sir. It is given on there.

1691 Q. This first one is II-R. Now, in that case we can see the plate in this light area and the electrode as a white line up above, is that right?

A. That is right. Here is the plate (indicating), and this is the electrode.

Q. And the sort of grayish layer over the plate indicates the height of the flux, does it?

A. That is right.

Q. And over here behind the electrode there are dark fissures or layers that run up through that, are there?

A. That is correct.

Q. And those would indicate escaping gases passing up through the layer of flux, would they?

A. That is correct, through the remaining layer of flux.

Q. So that there are open channels indicated there through the layer of flux?

A. That is correct.

Q. And they communicate all the way down to the area beneath the end of the rod?

A. That is right.

Q. This next one is III-R, and there again such channels appear, do they not?

1692 A. That is correct.

Q. IV-R was made with a somewhat lesser layer of flux, was it?

A. One-half inch.

Q. And there is a large and complete opening to the atmosphere through the flux layer, is there not?

A. That is correct.

Q. Just behind the rod and in front of it as well?

A. That is correct.

Q. And in VII-R, what is the height of the flux layer there?

A. An inch and a half.

Q. Is that taken with the electrode—
A. Stationary.
Q. —stationary?
A. The work piece stationary.
Q. And fissures there appear running up through the flux around the electrode, do they?
A. That is correct.
Q. Now in VIII-R is the work moving there or is it stationary again?
A. Stationary.
Q. What are these white dots or spatter that appear around the electrode?
1693 A. Very likely iron droplets, spatter.
Q. Being blown upward—
A. That is correct.
Q. —from the welding zone?
A. That is correct.
Q. Now, if I have it straight about this series of pictures, Doctor, your film No. II that you presented this morning as Defendants' Exhibit 121-B was taken under the same conditions as II-R, except that it was using Lincoln flux instead of clay, is that right?
A. That is correct. This is the Lincoln flux (indicating) and the other is the Robinoff flux.
Q. Now, in No. II here which shows the action with the Lincoln flux there is a little area down here beneath the tip of the rod which you pointed out to us is somewhat darker than the surrounding layer of flux. That is the one you pointed out this morning, is it not?
A. That is right.
Q. Now, that indicates, I believe you said, that the density of opacity of this material to X-rays is somewhat less at that point than it is somewhere in the flux
1694 area, is that right?
A. That is right.
Q. From that you concluded that that area represented vapor there, is that right?
A. A considerable portion of it is vapor, because you will have to remember one thing, and that is that in the arc zone there is also iron present, which has a very high density.
Q. What do you think that that is vapor of?
A. Vapor of iron with some vapor of silicate.
Q. Did you run any calibration tests to determine the

density or opacity to X-rays of the flux at different temperatures?

A. Will you restate your question?

The Court: Will you read it, please.

(Question read.)

The Witness: I did.

By Mr. Wolfe:

Q. What data can you give us on that?

A. On the photographic film the liquid flux is lighter than the granular flux; in other words, indicating that the liquid flux is more dense than the granular flux.

1695 By Mr. Wolfe:

Q. Do you have films that you can show us that on?

A. Not with me, no, sir.

Q. Well, can you on your film, Roman II here, point out to us any liquid flux that appears?

A. Yes, sir, at the very outside edge here. (Indicating on film.) There is a difference in opacity here.

Q. That is in a sort of halo?

A. Yes.

Q. Around the dark area—

A. Yes, sir.

Q. —to which you made reference before?

A. Yes, sir, right there (Indicating). The exposure is not the best to bring that out clearly. In other words, if you want to bring out that zone, you lose the contracts on the other.

Q. Do you have some pictures, which you took, to bring out that zone?

A. No.

Q. Well, now, over here to the left of the electrode in this same film—

The Court: Just a moment, please. Will you go back, Mr. Reporter, and read the last four or five questions and answers.

1696 (The record was read.)

The Court: Proceed.

By Mr. Wolfe:

Q. Again referring to your film here, Roman II, the plate appears to be higher to the left of the electrode. That I take it is the deposited weld metal; is that correct?

A. Yes.

Q. Then is there an overlying layer of fused flux on that deposited weld metal?

A. Yes, sir, that is correct. That is indicated by this light region, right here (Indicating).

Q. About how high up does that extend?

A. That extends up approximately the same height as the thickness of the weld.

The Court: Just a moment, please. I had in mind asking you this after all of your examination had been completed, but in order to understand these questions as we proceed, I will ask it now.

As between a molten flux and a granular flux, which would show lighter on the X-ray film?

1697 The Witness: The molten flux would, your Honor, because it is more dense.

Mr. Byron: I don't believe that answer is clear. You say it is lighter because the material is more dense?

The Witness: That is correct. The liquid flux is more dense than the granular flux, therefore it will show lighter on the film. Isn't that right?

Mr. Byron: I just want to know the answer.

The Witness: This could be brought out more clearly by a suitable change in exposure. Exposing that for a greater length of time will give you more contrast between the granular flux and the liquid flux.

By Mr. Wolfe:

Q. And you used an exposure which would give the maximum differentiation between the low density area beneath the tip of the electrode and the rest of the layer of flux, is that right?

A. Reasonable differentiation, perhaps not the maximum.

1698 Q. And that contrast in color here in that region there at the tip of the electrode and the remaining layer of flux indicates there is a lower density in that region?

A. A lower over-all density.

Q. And from that lower density you concluded, first of all, that the material was in that low density region in a vapor state, is that right?

A. That a portion of the material is a vapor state.

Q. And then from the fact that it was, as you concluded,

in a vapor state, you reasoned still further that therefore it was in an arc state?

A. I reasoned that an arc exists because no current of such high density –

Mr. Wolfe: Now, just a minute. I want to see what we can find from these X-rays.

Mr. Stewart: May he be permitted to finish his answer?

The Court: Read the question, and the answer as far as he went, and you may complete your answer.

(The record was read.)

A. (Continuing) —could be transferred by any other means than an arc, at that temperature.

1699 By Mr. Wolfe:

Q. What test did you conduct to measure the temperature in this region beneath the tip of the electrode?

A. We conducted no such tests.

Mr. Wolfe: I think we can take this light box down.

By Mr. Wolfe:

Q. In the course of your experiments with the Lincoln flux, Doctor, did you make any examination with probes of the location of a fused material below the surface of the granular layer?

A. I did not.

Q. Did you experiment with scraping away the overlying layer of granular material to see how far down you could take that, to observe the relative location of the rod and fused pool?

A. That would be impossible to do.

Q. You didn't try that?

A. No, sir.

Q. Did you make any tests with hollow electrodes, either by way of applying pressure through—gas pressure through the hollow electrode, or applying suction to it?

1700 A. I did not.

Q. Did you make any attempt to trap whatever material was around the tip of the electrode, for example, by sliding a sleeve down over the electrode to trap whatever was around it?

A. I did not.

Q. Now, you spoke this morning about using a welding rod that was coated with an insulated material.

What would you propose to use as the insulating material in such case, Doctor?

A. Any material which does not readily fuse; asbestos.
Q. At what temperature does asbestos fuse?
A. I don't know offhand.
Q. Would, say, some of this Lincoln flux do?
A. It could not be used as a continuous covering in the form of a granular material.
1701 Q. Well, I mean—
A. (Continuing) We would want it in the form where it could be a continuous covering.
Q. Would it serve if you could stick it on with something?
A. It might not be satisfactory, I don't know.
Q. As a matter of fact, there are very few materials, if any, which will remain insulators at the temperature at which the Lincoln flux fuses, isn't that so?
A. Heat or electrical.
Q. Electrical?
A. Most materials become somewhat conductive at very high temperatures.
1702 Q. So that even if you started out with this so-called insulating coating on there, by the time you got it down in a pool of fused Lincoln flux it would be conductive, would it not?
A. The flux itself might not be at a sufficiently high temperature.
Q. If it is in a high temperature state, then the coating will also be fused, will it not?
A. It will if the temperature of the flux is sufficiently high.
Q. And most of those materials become conductive before they actually become mobile liquids, do they not?
A. That is right. That is correct.
Q. Have you ever made any experiments with this coated rod business that you were speaking of this morning?
A. Personally I have not.
Q. That was just a matter of hypothesis?
A. That is correct.
Q. Would you expect the same sort of thing if you used, say, an ordinary welding rod like one of Lincoln's Fleetweld No. 5 with a cellulose coating?
A. The cellulose coating would very likely disintegrate rather early.
1703 Q. That would generate a lot of gas under there, would it not?

A. State your hypothesis more clearly. Do you have flux or don't you have flux?

Q. The same sort of thing you told us about this morning, this matter of putting down a layer of Lincoln flux, as I understood it, on a plate and then instead of welding in it with a bare rod, using a coated rod of some kind.

A. Welding in the flux?

Q. Yes.

A. Well—

Q. Well, if your coated rod was one with a cellulose coating like the one I mentioned, you would have a lot of gas generation there, would you not?

A. You may, depending on the cellulose.

Q. In fact, you probably would have so much—

A. And also depending on the dimensions of the rod.

Q. You would probably have—

A. It might be heated fully just by transfer of heat through the rod itself.

Q. You are not sure whether that would work or not?

1704 A. It would depend on the circumstances. It would depend on the properties of the material. You are simply mentioning cellulose. There are all varieties of cellulose.

Q. You are not familiar with the Lincoln Company's Fleetweld No. 5?

A. I am not.

Q. Have you attempted to do any welding in vacuum?

A. I have not.

Q. Did you hear Dr. Doan's testimony about the experiments which he conducted with Unionmelt and Linconweld and with coated electrodes in a vacuum tank?

A. I did not.

Q. Did you read it?

A. No.

Q. Were you present during any of Dr. Doan's testimony?

A. Part of it.

Q. And did you read any, which was given when you did not attend?

A. I did not.

Q. Well, I believe that I can give you the substance of that particular experiment which he reported.

1705 He told us that he had set up a large vacuum tank, in which he had located an automatic welding ma-

chine, which was controllable from the outside; that the atmosphere within the tank was brought down to about 200 or 250 microns; and that he found that he was able to make a sound weld with the Lincoln flux and with Unionmelt in that rarified atmosphere, or vacuum; but that with a coated rod, he just got a useless spatter of metal.

Is that the kind of thing that you would expect under such circumstances?

A. The very fact that he got a spatter, a spatter of metal, indicates that he has an arc.

The vacuum has nothing to do with the arc. The arc will operate in a vacuum.

Q. In the absence of such a spatter, then, would you say that he did not have an arc?

A. Well, in the absence of such a spatter—the reason is this, that the flux prevents the spatter; it encloses the region of the arc, and prevents the spattering.

Q. Did you say a moment ago that the vacuum has nothing to do with the arc?

A. An arc will operate in a vacuum.

1706 Q. In a complete vacuum?

A. Yes, sir, it will, after it has once been established.

Q. Will there be any change in the operation of the arc as the atmosphere is progressively rarified; that is, as the pressure is carried down, and down?

The Witness: The mechanism of the operation will still be the same.

By Mr. Wolfe:

Q. The appearance will be very different, however, will it not?

A. Very likely.

Q. And the length will be very different, will it not?

A. It may change.

Q. If you are attempting to do welding, the deposit of metal will be very different, will it not?

A. That is true.

1707 Q. Can you see the mechanism, of which you were speaking in your first answer to that question?

A. You cannot see the mechanism by means of which an arc operates,—only through the energy that is radiated.

Q. Now there is no question in your mind, is there, but what it is possible to make larger sound welds with

much higher current, using the Lincolnweld process, than is possible with an ordinary bare rod open arc?

A. I do not know, from my own observations.

Q. You just do not have any information on that?

A. I have never observed it.

Q. So that—

A. (Continuing) I have never seen very heavy current densities used.

1708 Q. You expressed certain opinions this morning, did you not, as to the similarity or identity of the electrical phenomena which takes place in ordinary open arc welding, and in the Lincolnweld process.

A. It is not a similarity of phenomena, but it is an identity in phenomena.

1709 Q. At the time you formed that opinion and stated it, you did not have information as to the size of sound weld that could be made with the Lincolnweld process or its maximum current, is that right?

A. I knew current densities of a thousand or even much higher densities could be used and were being used.

Q. And could be used with the Lincolnweld process to produce sound welds?

A. That is correct.

Q. And you knew such current densities could not be used to produce a sound weld with ordinary bare rod in air, didn't you?

1710 A. Not from actual observation.

Q. Have you ever heard of that?

A. I have been told that was said to be the case.

Mr. Wolfe: That is all.

Redirect Examination by Mr. Stewart.

Q. Doctor, only one or two questions. In the X-ray negatives which have been introduced as Plaintiff's exhibits, of welding operations using what you designated as the Robinoff flux—

A. The Robinoff flux.

Q. (Continuing) —is there any apparent difference, so far as the zone between the end of the electrode and the plate is concerned, between that zone in the pictures involving the Robinoff flux and the Lincolnweld flux, in general terms?

A. They both represent a dark zone. One is perhaps slightly darker than the other.

Q. And, Doctor, when you stated your opinion about the identity of the phenomena of the open arc and the arc under a deep bed of flux, you said it was not based on observation. What was it based on? In other words—

1711 A. My knowledge of what is generally taught, or what is always taught in regard to the transfer of electricity in an arc, general scientific information.

Mr. Stewart: That is all.

The Court: Doctor, I have one or two questions. I don't know whether they will be very scientific in phraseology, but can you produce a molten flux, if it is between two electrodes, charged electrodes, without having first produced an arc?

The Witness: That depends upon the potential that you apply.

The Court: Is it a possibility?

The Witness: Yes, it is a possibility, but the temperature, the heat energy evolved, may not be high, but it may be high enough to flux.

The Court: That is, you can put an electrode here (indicating) and have the flux represented by this tablet, and this electrode by this pencil, and the negative or the other pole by this pencil, and with a charge of electricity going through, beginning with this pencil, you can

1712 produce molten flux, develop an arc?

The Witness: Well, what happens in that case is, as you apply the potential, you have a lot of little granules; and at the point of contact where they meet, these little granules—the current is transmitted only at the point of contact. Those points of contact are of high resistance, and the material begins to fuse, and they fuse for an instant, producing a little arc; then more and more material will fuse. Gradually more and more of the material will fuse.

It would be fused much more rapidly if you could put in more energy, a higher current; but if you raise the current, then you are going to have to—after salt has been fused, you will set up an arc on account of the vapor produced, you see.

The Court: You mean the arc is the result of the fusion of the flux, or vice versa?

The Witness: The arc is the result of vaporization of the flux and the electrode. More vapors will be pro-

1713 duced; and after a certain length of time, the fusion will be entirely continuous.

The way that is done generally, the electrodes are close together like this (indicating), and you have only a small region between them. Then you establish an arc between the electrodes, and an intense amount of energy is liberated, which fuses the flux very rapidly, and the electrodes are separated. You wouldn't start by having them at the ends of the container, but would bring them close together.

The Court: I think I understand you, but I want to be sure about this phase of it. As between the fused flux and vapor, which you say combine to form an arc, the fused flux has a low resistance and a high—

The Witness: A high resistance and low conductivity.

The Court: And the vapor is opposite?

The Witness: Yes. I could give you the numerical values. No one has asked for the numerical values. I would be glad to give the numerical values.

1714 The Court: I think that is all the questions I have.

Mr. Stewart: May I ask just one question, then?

The Court: Yes.

By Mr. Stewart:

Q. Doctor, is there available information showing the comparative numerical value and conductivity of fused salt, in treatment based on technical experimentation? The question is, is there.

A. Yes. As I have stated before, on page 2020, the third volume of Landolt-Bornstein, the electrical conductivity is given for magnesium silicate.

1715 That quantity can be changed to electrical resistivity, to 577,000 per centimeter cube.

Iron of that same temperature, slightly higher, has a resistance or a resistivity of .000,255.

This (indicating) is higher in resistance by the number of times this quantity is contained in that, which is on the order of a million times. It can be verified by reference to the Smithsonian Official Tables, also to Landolt-Bornstein.

Q. Can you reduce that to a little more simple language, your comparison as to the resistivity?

A. They are both resistive. The resistivity is the resistance of a centimeter cube of any given material.

Q. And conductivity would be 1 over that?

A. That is right. Conductivity of this quantity would be 1 divided by that number, and—

Q. "that number", for the record, is 377,000 or is it 577,000?

A. This is 1. The conductivity is 1 over 577,000. The conductivity is 1 divided by .000255.

Q. And the first one relates to what?

1716 A. This is fused magnesium silicate.

Q. And what is the second?

A. This is iron in the liquid form, molten iron, at a temperature of 1,535 degrees.

Q. And that would be 1 over 577,000, as it relates to 1 over .000255, is that correct?

A. That is right, the ratio between these two numbers, 577,000 divided by .000255.

Liquid iron is much the better conductor than a fused silicate, that many times, and that is about, oh, over 3,000,000 times.

Mr. Stewart: That is all.

Recross Examination by Mr. Wolfe.

Q. What is the temperature for that silicate measurement?

A. The silicate measurement is 1,425.

Q. Centigrade?

A. Centigrade. The iron, this quantity here, is 1,535 degrees Centigrade.

At a lower temperature approximating this, this would be considerably lower. The resistance of the metal steadily increases until it reaches its melting point, then there is an abrupt increase, and then a further increase in

1717 the molten state.

Mr. Wolfe: That is all.

Mr. Stewart: That is all.

(Witness excused.)

(And thereupon at 3:00 o'clock p.m. the hearing was adjourned to the Graver plant at 4809 Todd Avenue, East Chicago, Indiana, where the following proceedings were had:)

1718 Mr. Oberlin: If the Court please, the demonstrations as listed on Defendants' Exhibit 119 for identification, will now be given in the order in which they there appear.

The first one will be a demonstration of hand welding with coated rod, that is, the conventional or regular com-

mercial operation, which we are now going to demonstrate, using the regular commercial weld rod of the coated type.

It is fully identified, and the character of the plate is fully identified here, and the current conditions are all listed on this sheet.

I should explain that this demonstration will consist only of one of several passes that are usually made in welding a plate of this thickness, namely, five-eighths inches, the previous passes having already been laid down, so that the operator in this case will merely lay down what we call the final pass, merely to illustrate actual commercial welding with the coated weld rod.

1719 The operator in charge will be the chief engineer of the Lincoln Electric Company, Mr. George G. Landis, and since he may be called upon to make some statement, explanatory or otherwise, during the conduct of this or other succeeding demonstrations, if the Court please, I should like to have him be sworn at this time as a witness, and he will appear on the stand in Court at a later session.

GEORGE G. LANDIS, called as a witness on behalf of the Defendants, having been first duly sworn, was examined and testified as follows:

Mr. Oberlin: Now if the Court please, we are ready for the first demonstration, we will proceed to the further end of this bay, where the apparatus has already been set up, and the plates made ready, to perform the operation. Shields will be required in observing this demonstration.

Mr. Wolfe: May I ask a question right there.

1720 Do you have a Lincoln catalogue, or anything of that kind, that lists these coated rods?

They are not familiar to me.

The Witness: I do not have one with me. It is a hot rod, however, if that would mean anything to you.

Mr. Oberlin: We will produce such a catalogue.

Mr. Wolfe: And are the currents and voltages those which your operating manual lists as normal?

The Witness: They are within the ranges as listed there, yes, sir.

Mr. Oberlin: May I suggest that the questions be limited as far as possible to what is necessary to be asked,

under the conditions here, as I stated previously, the witness will be available, to give a full explanation of anything that may be required.

(Demonstration No. 1 was then run.)

1721 Mr. Stewart: We want the electrode that was just used marked as an exhibit.

(Whereupon the said article was marked Defendants' Exhibit 122 for identification.)

Mr. Stewart: We will have the plate which was just welded marked as the next exhibit.

(Whereupon the said article was marked Defendants' Exhibit 123 for identification.)

Mr. Oberlin: We have now concluded the first demonstration on the list, Exhibit 119 for identification. We shall preserve and produce in court the plates as they carry the weld rod just made, with the unused sections or pieces of weld rod used.

We will now proceed with the second demonstration in a few minutes—immediately in fact. In this demonstration a Lincoln coated rod, LH-70, a commercial rod, will be used and the welding will be done through a deep layer of Lincolnweld 660 flux. It will be carried on, instead of with a bare rod, with a coated rod.

1722 I may add that in the second demonstration the coated weld rod will be used initially in a pass not through a deposit of flux. Its operation will be illustrated in both ways.

(The demonstration was then given. Samples of the welding rod used in Demonstration No. 2 were marked, respectively, Defendants' Exhibits 124 and 125; and the plate welded in Demonstration No. 2 was marked Defendants' Exhibit 126, for identification.)

Mr. Oberlin: Now, if your Honor please, we will next proceed with Demonstration No. 3. If anybody wants to check meters, and so forth, we have somebody assigned to that job. We will now proceed with Demonstration No. 3 on the list, Defendants' Exhibit 119 for identification.

This is a demonstration of Lincolnweld automatic welding, with an apparatus used regular in the plant of the defendant, Graver Company. The apparatus may be inspected by the experts present for the plaintiff, as to the manner in which the current is measured, and otherwise. They may be stationed where they may observe the operation.

As I understand it now—and I would like to have
1723 you check me as to this, Mr. Landis—the operation is going to be conducted under Lincolnweld 660 flux, disposed in a continuous layer or windrow but in varying depths.

In other words, there will be an initial section of this layer, or windrow, which is, as I understand it of the depth ordinarily employed here in this factory of the Graver Company; and then there will be an interval, where the thickness of the layer will be approximately one-half inch; and then there will follow a section in which an increased depth is employed; that is, a layer then follows, the depth of which is higher than is normally used, as I understand it, in the commercial practice of welding, using this process in the defendant Graver plant.

As soon as counsel for the plaintiff have satisfied themselves as to the depth of the layer employed, or as to anything else involved in this demonstration, the demonstration will proceed.

Mr. Wolfe: Will you measure the layer, Dr.
1724 Doan; measure the length of the center section also.

Dr. Doan: About seven-eighths of an inch, at the electrode.

Mr. Oberlin: Now, a limited number of observers can safely stand over on the platform there. There is a step provided for them over there, from which they may watch the demonstration more closely, if they desire to do so. That invitation is also extended to the Court, if the Court cares to do so.

Mr. Wolfe: Have you some other measurements to state, Dr. Doan?

Dr. Doan: One and three-eighths inches, six inches beyond the electrode—or rather, that is, six inches in front of the electrode; one-half inch for a distance of two inches at the middle; and about an inch and seven-eighths in the second section.

Mr. Landis: You mean, the third section.

Dr. Doan: Or rather, the third section.

1725 Mr. Oberlin: Just let us know whenever you are ready, please, counsel.

Mr. Wolfe: All right.

Mr. Oberlin: This is regular welding practice. I might state that this operation will be conducted first on one side, and then on the other of the two pieces which are being

welded together. That is what we refer to as the first pass and the second pass, in the memorandum, Defendants' Exhibit 119 for identification.

Mr. Landis: Are you ready to go ahead now?

Mr. Oberlin: All set.

(The third demonstration was thereupon begun.)

Mr. Oberlin: The first pass, that is, the weld on one side of the plates being welded, has now been completed, and the flux will be removed, together with the slag, and then we will proceed with the second pass, namely, the weld that completes the operation on the other side.

Mr. Landis: Shall we put the plate down, so they 1726 can see it, Mr. Oberlin?

Mr. Oberlin: Well, the plate, of course, will be retained anyway.

I just want to caution the Court, because the next operation will be to tackweld this plate to the supporting bed, so we should look out for flash. The welding operation that was carried on, on the other side, will not be repeated on this side.

Mr. Landis: Does anybody want to measure anything here?

Mr. Oberlin: Does anybody want to measure this?

Mr. Wolfe: Will you make those measurements, please, Dr. Doan.

Dr. Doan: One and a quarter inches at the electrode; one and a quarter inches at the end of the first section; half an inch in the second section, opposite the yellow mark; and two inches in the third section.

Mr. Landis: Are we all set now?

Mr. Oberlin: Have the measurements been completed?

1727 Dr. Doan: Yes.

Mr. Oberlin: All right. You may proceed.

(Thereupon demonstration No. 3 was concluded.)

Mr. Wolfe: What was the travel speed on that?

Mr. Landis: I will get that from the operator, exactly. This is not calibrated. I think what we ought to do is to actually measure it. It takes only a minute to do it. I would feel better about it if you did. I have checked it, but I would like to be sure.

Mr. Wolfe: Very well.

Dr. Doan: Mr. Wolfe, I think that it ought to be recorded that these plates were not clean.

Mr. Wolfe: Will you check the travel speed with Mr. Landis, please.

Mr. Oberlin: A request has been made by someone that the slag be left intact. Is that your desire?

Mr. Wolfe: Just a moment, please, and I will check and see.

1728 Mr. Landis: Do not break the slag. Just push it aside. Be careful not to crack it.

Dr. Doan: The height of the slag is about the same all the way along.

Mr. Oberlin: All right. You may break it loose, but save a piece.

(Whereupon the said sample of slag produced in demonstration No. 3 was marked Defendants' Exhibit 127 for identification; and the plate welded in demonstration No. 3 was marked Defendants' Exhibit 128 for identification.)

1729 Mr. Oberlin: Now, if the Court please, there will now be carried out the final demonstration as shown on this list, which is not a demonstration of welding, but of the submergence of the arc under a granular material, which, I am given to understand, is pure silica sand, that is, 99 per cent silica sand, to illustrate the effect of a granular material, as affecting the visibility of an arc between the electrode and the metal work piece, as in the previous welding operation.

Mr. Wolfe: These plates will all be preserved, will they?

Mr. Oberlin: Yes. They will all be marked with Exhibit numbers by the Reporter, and will be available for examination at any time.

Mr. Wolfe: Can we arrange to have them X-rayed? That might as well be done here at the Graver plant.

Mr. Oberlin: If that is agreeable, you can have it done right here with our equipment.

1730 Mr. Wolfe: We will have one of our men come over and get in touch with Mr. Bradburn.

Mr. Oberlin: I will arrange for that. I assume, however, that that will not include this last one, because we are not presenting this as a welding operation.

Mr. Wolfe: We can decide that later. What have you to say as to the travel speed, Dr. Doan?

Dr. Doan: 14 inches per minute.

The Witness: On the second pass.

Dr. Doan: Yes.

The Witness: Set it where you had it, on the first pass.

Mr. Oberlin: Can we now have the welding gone ahead with?

The Welder: I have the speed set for the first pass.

Mr. Oberlin: Take it, then.

Dr. Doan: 17 inches per minute, on the prior run.

Mr. Oberlin: All right. Now, let us go with this last
1731 one, as quickly as we can.

Mr. Wolfe: Just a moment, please. Will you measure the depth of the sand, Dr. Doan.

Dr. Doan: About 2-1 8ths inches, with a pile of about one inch at the electrode.

Mr. Wolfe: Were the edges of each of these plates flame-out?

The Witness: Yes, they were. There was no preparation, no removal of oxide, and no steel wool used.

Mr. Oberlin: And was that true of all of the plates used in this automatic demonstration?

The Witness: Yes.

Dr. Doan: I would like to make one more measurement. It is 1-3/8ths inches at the bottom of the spout.

Mr. Oberlin: All right. Go ahead.

(Demonstration No. 4 was thereupon run.)

Mr. Stewart: May I see the end of the rod, please.

Dr. Doan: May we have the end of the weld rod marked as an exhibit?

1732 (The end of the weld rod used in Demonstration No. 4, the slag produced in the Demonstration, and the plate welded, were thereupon marked respectively as Defendants' Exhibits Nos. 129, 130 and 131 for identification.)

Mr. Oberlin: That concludes the demonstration, if your Honor please.

Dr. Doan: Just a moment, please. That speed was 21 inches per minute; 600 amperes; 37 volts; no penetration visible from the bottom at all.

Mr. Oberlin: The last welded plate has been marked, I believe, and some of the slag formed from the flux has likewise been marked.

That concludes the demonstration at this time and place, your honor.

1733 The trial of the above-entitled cause was resumed, pursuant to adjournment.

Present:

Same as before.

PROCEEDINGS.

Mr. Oberlin: If your Honor please, Defendants at this time offer the following Exhibits in evidence, heretofore marked for identification, namely, Defendants' Exhibit No. 119, being the list of demonstrations that were carried out at the Graver plant yesterday afternoon; Defendants' Exhibit No. 120, which is a chart identified by the
1734 witness, Dr. Nusbaum; Defendants' Exhibits Nos. 122 to 131 both inclusive, being samples of welded plates and other materials identified in connection with the demonstration yesterday afternoon at the Graver plant.

Now in the stenographic transcript of the proceedings at the plant of the Graver Company yesterday afternoon, the following corrections will please be noted by the Reporters, which have been agreed to by counsel:

First, at page 1719 of the transcript, the middle initial of the witness, Mr. Landis, is G. His name is George G. Landis.

On page 1730, the third line from the end, Dr. Doan's statement reads "17 inches per minute" instead of "per second."

On page 1731, the 9th line, the statement of Mr. Wolfe should read "flame-cut" instead of "plain."

These errors were due, undoubtedly, to the difficult conditions under which the testimony was taken and
1735 the proceedings noted.

Mr. Stewart: There is still another correction, I believe.

Mr. Oberlin: There is still another one, which has also been agreed to by counsel.

On page 1718, the 6th line from the bottom, where the transcript reads "five inches" the correct reading should be "5/8ths inches", referring to the thickness of the plate that was used in the demonstration.

(And thereupon DEFENDANTS' EXHIBITS 119, 120, and 122 to 131, respectively, were admitted in evidence.)

1736 GEORGE GIDEON LANDIS, called as a witness on behalf of the Defendants, having been previously duly sworn, resumed the stand and testified as follows:

Direct Examination (Continued) by Mr. Stewart.

Q. Your name is George Gideon Landis?

A. Yes.

Q. And you are the chief engineer of the Lincoln Electric Company; is that correct?

A. Yes, sir.

Q. How long have you held that position?

A. Since 1931.

Q. You conducted these demonstrations, or you supervised them, yesterday in the plant of the Graver Tank and Manufacturing Company; is that correct?

A. Yes, sir.

Q. Now, with regard to Demonstration No. 1, which has the heading on Defendants' Exhibit No.
1737 119 "Demonstration of Hand Welding with Coated Rod":

Will you please explain what that demonstration was.

1738 A. That demonstration consisted of running a coated electrode under conditions that would normally be used in the welding of plates.

We prepared the plates to show the groove which was being filled by the electrode, in order to give a more accurate representation of what was going on, although we could have had a bead run on flat surface, if we had desired to do so.

Q. There had been, had there not, several passes made in that groove before the final one demonstrated was put on?

A. Yes.

Q. How was the welding itself done, with one or more passes of the electrode?

A. The plate was welded with two sticks of electrode. The first stick was consumed as far down as the operator could consume it, and the remainder of the pass was finished with part of the second electrode.

Q. Now, what covering of the weld metal or the bead resulted from that operation?

A. The covering of the bead at the end of the first
1739 stick of electrode was complete. The operator chipped off the slag covering at the finish of the bead so he would be able to finish the weld properly without welding over the slag.

Q. When the entire pass was completed, the first part from one end and the other part from the other end, was that coating of slag removed or left on?

A. Except for the small amount of the first bead that was run, the slag was left as it was at the end of the operation.

Q. That would normally be chipped off, in normal practice, would it not?

A. Yes.

Q. And still can be chipped off, as that plate remains?

A. It can be chipped off.

Q. Now, the second demonstration is headed "Demonstration of hand weld with coated rod under Lincolnweld 660 flux."

Will you state what took place there, and the amperages and voltages that were used?

A. The test consisted of welding with three electrodes, electrodes of 3/16 inch diameter, and coated according to Lincoln LH-70 specification.

1740 The first rod was struck in the open but was passed into a layer of Lincolnweld 660 flux. The arc was, of course, visible for a few seconds, and then later on was at least partially submerged under the flux, in a manner similar to automatic welding.

The second rod was run in a similar manner.

The third rod was run with the same current setting and in the same manner, except it was run in the open with no addition of the Lincoln 660 flux.

Q. What was observable about the molten flux in the demonstrations, where the Lincolnweld granular flux was used and the welding was done underneath it?

A. In both cases the molten flux ran out over the starting point of the bead.

Q. And what was observable about the end of the electrode and the coating in all three demonstrations, two under the granular flux and the others in the open?

A. The ends looked liniar in each. The coating on the rod extended slightly beyond the end of the metallic electrode.

1741 Q. What does that indicate?

A. That the passage of current is from the tip of the electrode to the plate being welded.

Q. And by what means?

A. An arc.

Q. Now, the next demonstration is entitled—this is No. 3: "Demonstration of automatic welding under Lincolnweld 660 flux (varying depths)."

What instructions did you give the operator who operated the machine at the beginning of the demonstration, or at any time?

A. I beg pardon, what was the other question?

Q. Or at any time.

A. The instructions given to the operator were to set his machine as he would to weld a plate, which would result in as perfect a weld as he was capable of making commercially, and that he would use in commercial practice.

Q. Did that include both the current voltage as well as the depth of the flux?

A. Current voltage, speed of travel, and depth of flux for that particular setup, yes.

1742 Q. Now, in setting up, in putting the flux on, what can you tell us as to what was done about the three different sections of the plate that were to be welded, so far as flux depth is concerned?

A. The first six inches was put on as the operator said he would put it on in commercial practice.

The middle part, the next six inches, was determined by me and arranged so it would measure half an inch, a half inch depth of flux, gauged by two parallel bars which were a half inch wide and placed on top of the plate.

The last six inches of flux was piled on, so it was definitely more than would be used in their commercial practice.

Q. Now, Mr. Landis, what were you able to observe during the progress—first let me ask you: Were any markings put on the plate itself in the way of chalk marks?

A. I marked the area, approximately two inches long, where there was only a half inch of flux.

Q. With what did you mark it?

A. With yellow chalk.

1743 Q. What about a description of the plates for that demonstration, Mr. Landis?

A. We used the plates that came out of their stock pile and were available for their use in their com-

mercial practice, and prepared them by flame cutting the edges, the same as they do.

Q. What do you mean by flame cutting the edges?

A. Using an axyacetylene torch and burning the plate to the proper dimension, but not finishing it in any way, such as planing or grinding after the flame cutting operation.

Q. Was any bevelling done to these plate edges which were welded together?

A. No preparation of any kind after the flame cutting of the plates, except the necessary tacking of the plates preparatory to welding.

Q. By "tacking" do you mean a hand welder was used to put on a small tack weld at each end so they would stay together, is that correct?

A. In addition to the tabs which are put on each end so the arc may be started and stopped off of the plate that is being welded.

Q. What about the surface of the plate, Mr. Landis? What was done, if anything, to the surface prior to welding?

1744 A. There was no preparation of any kind.

Q. Was any rust or oxide or anything else removed?

A. No.

Q. Now, in the course of that operation through that varying layer of flux, what were you able to observe?

A. Well, during the welding of the first six inches there was the usual occasional flashing visible flame, that we all know about. In the center section where we had only one-half inch of flux there was very definite arcing. In fact, it was severe enough so it would not be wise to look at it except through a shield.

As the electrode approached the heavier layer it became more and more submerged until it was only an occasional flame that was visible.

Q. By "flame" what do you mean? What color flame?

A. In the third layer you are referring to now?

Q. Yes.

A. The flame I am referring to, I believe, is common to any burning gas. The arcing is peculiar to the arc process, of course.

Q. Now, the fourth demonstration, Mr. Landis, is de-

scribed as a demonstration of submergence of arc
1745 under silica sand. What kind of sand was that? In other words, what was its chemical consistency?

A. We specified chemically pure sand, which is 99 per cent silica.

Q. Will you describe that demonstration, as to what took place?

A. In that case I told the operator to run at 600 amperes at whatever speed he had. In fact, I did not know what speed it was until we had measured it later, but it is within the range of usual welding speeds.

The purpose of that demonstration was to show the submergence of the arc only, and was not intended to represent a completely welded plate.

Mr. Stewart: That is all. You may cross-examine.

Mr. Cahill: May we have a moment?

The Court: Yes.

Mr. Wolfe: No cross-examination.

The Court: I have one question. With respect to Test No. 2 I believe you said there was an arc because of the fact that the electrode, the coated electrode showed a portion of the coating beyond the point where the elec-
1746 trode itself had melted. Why would that indicate, if it does indicate, that there was an arc?

1747 The Witness: One of the purposes of the test was to show that the ends of the electrode, whether the electrode was submerged under Lincolnweld 66 flux, or whether it was run in the open, would be identical.

The ends of the electrode show the arcing surface of the metal part of the electrode, in both cases.

The third electrode which was run, was definitely run in the open, with an open arc, and that showed the condition at the end of the electrode, which was the same as the condition on the end of the electrodes which were run under the submerged flux.

The Court: The fact that the coated material would be on the end of the burned electrode, has no significance —or has it?

The Witness: It is usual in welding with coated electrodes of that type.

The Court: I have no further questions.

Mr. Stewart: Might I ask possibly just one further question, your Honor?

The Court: Yes.

By Mr. Stewart:

1748 Q. Is that coating ordinarily a conductor of electricity, or does it have an extremely high resistance?

A. Cold, it has a very high resistance, but of course that resistance changes as the temperature is increased, of the coating.

Q. But so far as taking any of the welding current is concerned, what proportionate amount, if any, could go through that coating?

A. A very insignificant amount.

Mr. Stewart: That is all.

Mr. Wolfe: No questions.

(Witness excused.)

Mr. Oberlin: Your Honor, Dr. Booth will be called as the next witness for the defendants.

HAROLD SIMMONS BOOTH, called as a witness on behalf of the defendants, having been duly sworn, testified as follows:

Direct Examination by Mr. Oberlin.

Q. Your full name is Harold Simmons Booth?

A. Yes, sir.

1749 Q. You reside in a suburb of Cleveland, Ohio?

A. Yes, sir. Hunting Valley.

Q. What is your occupation or profession?

A. I am professor of chemistry, and chairman of the Department of Chemistry at Western Reserve University.

Q. And that university is located in Cleveland, Ohio, is it?

A. Yes, sir.

Q. How long have you held the particular position on the faculty of that university which you have described?

A. I have been professor of chemistry since 1937, and chairman of the university department of chemistry since 1942.

Q. How long have you been connected with the faculty of that university altogether?

A. Since 1919.

Q. And always with the same department?

A. Yes.

Q. That of chemistry?

A. Yes, sir.

Q. What was your educational preparation for your profession, Doctor?

1750 A. I received my Bachelor of Arts degree from Adelbert College, Western Reserve University, in June, 1915; by Master of Arts degree from the graduate school of Western Reserve University in 1916; and my Ph.D. degree from Cornell University in 1919, June, 1919.

Q. In the course of your preparatory work, and in particular, your preparation for your doctorate, as well as all of your work subsequently, have you specialized in any particular branches of chemical science?

A. I specialized in the field of inorganic chemistry. At the present time I teach all of the inorganic chemistry, that is, the graduate inorganic chemistry, and the advanced inorganic chemistry, in the university.

At the same time, I minored at Cornell University in electrochemistry.

Q. Have you, in either one of those fields, given still more specific attention to any particular subject-matters?

A. Yes, sir, I have. Since I have gone into university teaching, my earlier researches particularly were in the field of electrochemistry, particularly in connection 1751 with nonaqueous solvents; and at all times I have been interested in fluoride chemistry.

My major work has been in the field of fluoride chemistry.

Q. Fluoride chemistry is the chemistry of compounds in which the element of fluorine enters; is that correct?

A. Yes, sir.

1752 Q. Have you had any experience with the compounds, the class of compounds, that we have been dealing with here, such as silicates, more especially metallic silicates?

A. Yes. Beginning in 1924 there was established a fellowship under my direction for the study of reactions that take place under high temperature in vitreous enamels.

Vitreous enamels consist of silicates, various oxides, also fluorides.

That went on continuously up to 1942, when the war stopped the work we had been investigating, on the reactions of that type.

Particularly we had studied calcium fluorides and silica, sodium fluoride and silica, and other metallic fluorides

and silica, and also those with silicates, at high temperatures.

We have also carried on some investigations outside of the field of fluorides, with inorganic chemistry, at high temperatures.

Q. What societies do you belong to? Name at least a few.

A. I am a member of the American Chemical Society, the Electro-Chemical Society, the American Associa-
1753 tion for the Advancement of Science, and I am a Fellow of the American Academy of Arts and Sciences.

Q. I assume you have published books and papers in the course of your professional career, Doctor?

A. Yes.

Q. You need not enumerate them in total, but have you published any that deal with the particular subjects you indicated you specialized in, namely, fluoride compounds and silicates, or silica fluorides?

A. Yes, I have published well over a hundred papers, of which the majority were in the field of fluoride chemistry.

I have published, as co-author, a book on Elementary Quantitative Analysis, a course which I gave for many years but do not any longer; and I was editor-in chief and originator of the works called Inorganic Synthesis. The second volume has been published. In this case, I was associate editor.

Q. Have you had any experience in the practical application of chemistry, that is, in manufacturing processes?

A. Yes, I am consultant to the Wyandotte Chem-
1754 ical Company, manufacturers of heavy chemicals.

Q. Located where?

A. Wyandotte, Michigan. Some of their products are silicates made at high temperatures.

Q. Just speak a little more slowly, for the benefit of both the reporter and the hearers, and the Court.

A. (Continued) Also consultant of Harshaw Chemical Company.

Q. Where are they located?

A. Located in Cleveland. They are producers, probably one of the leading producers, of fluoride of various sorts, and also they are one of the leading producers of ceramic materials, silicates, colors made of silicates; also, they are leaders in the field of supplying materials and processes for electrochemistry, plating, and so forth.

Q. Have you had any other connection doing research work or otherwise, outside of the University itself, that you might mention?

A. Yes, I have. I have been consultant at various times for other corporations.

Q. Any public or governmental agency?

A. During the war I was consultant to the U. S. Naval Research Laboratory, Washington, D. C., and was director of the Western Reserve University Station of the
1755 United States Naval Research Laboratory.

Q. You have been asked, and have you reviewed or studied the patent in suit?

A. Yes, sir.

1756 Q. The patent on its face relates to two aspects, one a process, an alleged novel process of electric welding, so-called, and another, a composition of matter allegedly useful in carrying out that process; to which particular aspect has your attention been more especially turned?

A. To the chemical aspect.

Q. That is, to this composition of matter?

A. Yes.

Q. What is that composition as described or taught in the patent in terms of chemistry, Doctor, and point out where it is described?

A. On the bottom of page 2, column 2, there is a table giving the composition of welding compositions which are representative examples within this invention, according to the statement.

These can be described as compositions of metallic silicates with calcium silicate as the major constituent, with other adventitious and minor constituents.

Q. In the completed composition is there any other ingredient added or suggested for addition?

A. On the next page, the top of column 1, page 3, it says that before use there is to be added to this composi-
1757 tion one ounce of calcium fluoride per pound of the composition.

Q. What are the components as listed in the table that you have referred to at the bottom of page 2, column 2, that enter into the composition of the silicates that you identify as constituting the compound or composition?

A. Calcium oxide, magnesium oxide, aluminum oxide and a fraction of a per cent of ferric oxide, and I presume that is there as a silicate.

Q. The amount of that is so small that it would indicate it is present how?

A. I think it is an impurity, it is so common everywhere as an impurity.

Q. How about the alumina? That is the next to the last item in the table, is it not? What about the amount of that and its presence as indicated in the patent?

A. Well, the patent states that the materials used were of the purest quality used in the ceramic industries, but the fused product showed the presence, on analysis, of about five per cent alumina. Now, five per cent alumina, or approximately that, is in each of these samples.

1758 Q. How does it happen to be there, as you understand the statement in the patent to which you have just referred?

A. Accidentally, as an impurity in the raw materials.

Q. Would such an amount of alumina be plausibly explained as occuring as an impurity with the other ingredients named in the same paragraph, beginning with line 51, column 2, page 2 of the patent?

A. It might have been in the limestone used, because argillaceous limestones do have alumina in them.

Q. When you say "limestone", which of the preceding ingredients named in the paragraph is identified as limestone?

A. Calcium carbonate.

Q. That is the chemical name for limestone?

A. That would be a pure limestone.

Q. You have stated, Doctor, that the composition thus described in the patent as suitable for use in the electric welding portion of the patent comprises, as I understand you, a combination of silicates, metallic silicates?

A. Yes.

1759 Q. What do you know about silicates in general? First of all, do they occur naturally?

A. Yes.

Q. That is, in nature?

A. Yes.

Q. In any large number?

A. Thousands of them.

Q. And all over the world?

A. Yes.

1761 Q. You did define the composition as described in the patent, as being a combination or mixture of

metallic silicates, in which calcium silicate is a predominant or major constituent, I believe.

A. Yes.

Q. Would you be able to determine, without test or examination, whether any particular one of those naturally occurring silicates came in that category?

A. Not in my opinion, no, sir.

Q. Now, Dr. Booth, while I asked you to which aspect of the patent your attention was more particularly directed, and you stated that it was to the composition, have you also given consideration to the availability of various compositions, including those thus described in the patent, in actual welding operations as described in the patent?

A. Yes.

Q. Have you seen such welding operations carried 1762 out with varying compositions?

A. Yes, sir.

Q. Such as described in the patent, and otherwise?

A. Yes, sir.

Q. I believe you stated that you have had experience heretofore with electrolytic chemistry?

A. Yes, sir.

Q. What is the nature of the procedure that is involved in that branch of chemistry, doctor?

A. Well—

Q. Is the electric current used?

A. Yes, sir. The current passes through either an aqueous or non-aqueous or fused electrolyte, and it is carried by the ions.

Q. Can you give us an example of the use of electric current in a fused electrolyte, for carrying out a chemical process?

A. Yes, sir. One which resembles rather closely the conditions given here, as close as one can find the composition, is the electrolytic production of aluminum, in which a bath of cryolite aluminum oxide and calcium fluoride, is used, carrying varying amounts of calcium fluoride and aluminum oxide.

Aluminum oxide is given in the patent, and so is 1763 calcium fluoride.

Q. Two of the same ingredients are employed in the electrolytic production of aluminum, then.

A. Yes, sir.

Q. What is the operation? Let us hear a little bit more about that, in thus producing aluminum.

You are talking about the metal, aluminum, now, are you not?

A. Yes, sir.

Q. Yes.

A. The aluminum metal collects in the bottom of a more or less flat-shaped, large cell, and becomes a cathode. Suspended in the fused electrolyte from above are carbon electrodes.

The bath, specifically, usually contains from 10 per cent to 20 per cent dissolved alumina.

Now, as the bath runs—they do not change the bath, or renew it, for a considerable time—it gradually accumulates silica from the alumina which is added, because there is that slight impurity in the alumina, one that they would like to eliminate, but cannot; so that eventually the bath has to be thrown away, because it has accumulated
1764 a considerable percentage of silicates.

The voltage drop in such a cell is 6.3 volts under normal operating conditions.

The current density at the anode is between 100 amperes and 125 amperes per square decimeter.

Q. The anode is the carbon electrode?

A. Yes.

Q. That projects down into this electrolyte?

A. Yes.

Q. And the electrolyte is a fusion of the chemical compounds which you named?

A. Yes, sir.

Q. Including calcium fluoride and alumina?

A. Yes, sir.

Q. That is, oxide of aluminum?

A. Yes, sir.

Q. Now while we are on this subject, Doctor, is there a limit to the current-carrying capacity of such a fused electrolyte in this specific instance, if you know.

A. Yes, sir, there is. When the current density, that is the number of amperes per square decimeter at the
1765 anode, gets too high, there develops what is called the anode effect.

The anode effect is a phenomenon in which, in the first stage, a gaseous film forms on the anode, which increases the resistance; and then, as the current density rises, there is a luminous glow, which can be seen in the dark.

The anode effect, in the case of the aluminum cell, begins around 400 amperes per square decimeter.

At 1,000 amperes per square decimeter, it becomes very serious.

There is visible discharge between the electrolyte, through a gap, and the anode.

Q. Is that a condition of operation that is desirable in this electrolytic reduction of alumina?

A. No, very much to the contrary.

Q. So that is something to be avoided, is it?

A. It is not desirable because fluorine and other gases come off in the process.

Q. What is the character or the nature of the production of current when that stage is reached? What does it at least approach?

A. It is beginning to change over to the condition
1766 of an arc.

Q. And that is undesirable, is it?

A. Yes, sir.

Q. In the particular electrolytic operation?

A. Yes, sir. It is through this gas film—the conduction is through the gas film, and is not electrolytic.

Q. Now you have spoken of current density in terms of square decimeters.

What does that area correspond with in English measurements?

A. Well—

Q. In inches.

A. 2.54 centimeters equal one inch, so that it would approximately be an area of four inches on a side.

Q. And is that the usual basis for figuring, at least among chemists, current intensity in an operation of this sort?

A. It is in electrolytic operations, yes, sir.

Q. Have you noted or determined from the data given in the patent in suit, the current densities which it is proposed should be employed?

A. Yes.

1767 Q. The data for that determination is found in the patent at the bottom of Column 2, page 3; is that correct?

A. Yes, sir.

1768 Q. What determination have you made in that respect? And compare such determination with that which you have noted in the case of electrolytic reduction of aluminum.

A. Since the electrode diameter is in inches, the current density has to be converted into terms that are common to the electrolytic term.

Q. That is understood.

A. (Continuing.) Into amperes per square decimeter.

Q. You have given that in the case of figures noted in the patent, have you, Doctor?

A. Yes.

Q. What is the relation?

A. As a specific case, suppose we take the 3/16 inch electrode. The 500 stated here becomes, under those conditions, 280,740 amperes per square decimeter.

The upper limit, 800, becomes 449,180 or nearly half a million amperes per square decimeter.

Q. That current density is compared with what current density that you state marks the anode effect in an aluminum cell?

A. It is 600 times the current density at which the 1769 anode effect begins in the aluminum cell. It is 250 times the current density at which serious anode effect obtains in the aluminum cell.

It is four times the former arc welding current density, as given in the second column, where old methods are described.

It is 125,000 times the current density at which, on an iron anode in aqueous solution the anode effect begins to appear.

Q. And the anode effect you have indicated is the first stage toward an arcing condition whereby a current is conducted from the electrode to the opposite pole?

A. Yes.

Q. Now, Doctor, let's come back to the subject of silicates. In addition to metallic silicates, which I believe you stated occurred numbering thousands in nature, are there also what we call synthetic or artificially-prepared silicates known?

A. Yes, sir.

1770 Q. In what number, generally?

A. I think they would be in the hundreds, because they are used in the ceramic industry. In various compositions they are used to obtain various effects.

Q. Describe more particularly the synthetic compounds used in the ceramic industry, identifying them first with some known object.

A. First we can talk about ordinary porcelain objects, or dishes. The body of that ware usually consists of clay, which is an aluminum silicate; along with that is added ground up fluorspar, which is a potassium aluminum silicate, and various other ingredients as experience dictates.

Q. These enter into the body of such ware?

A. Yes.

Q. You spoke earlier of glazes. Are they also metallic silicates?

A. They are of glass, and more complex,—calcium-sodium-aluminum silicates. When they are desired to be opaque, calcium fluoride is added.

There are all sorts o vitreous enamels. The enamels that are used for, let us say, stoves, are very complex, because the coefficient of expansion must be right for the steel.

1771 Q. From such tests as you have made of welding compositions as described in the patent, would you consider it proper or possible to employ any one of these various enamels in the ceramic industry, without experiment, as a welding composition?

A. No, I don't think so.

Q. How only could it be determined whether any particular one of these ceramic silicate compounds would be thus usable?

A. I think they would have to be tried, because the specifications in the patent limit the behavior, and you would have no certainty that the silicates would behave as described unless you tried them.

Q. That is, if you took a particular ceramic type silicate, such as is used as a stove enamel, even though it is a silicate, would you expect it to work necessarily as a flux as called for by the patent?

A. No.

Q. Would it work if you added alumina knowingly to such ceramic frit?

A. I do not know.

Q. Only how could you determine?

A. By trying it.

1772 Q. Would that be true, equally true, assuming that this ceramic frit did not include calcium fluoride and you added calcium fluoride to such ceramic metallic silicate? Would you know whether it would work without trying?

A. No.

Q. We have been talking about metallic or metal silicates. Is there any other kind than a metallic silicate in this rather large group of compounds?

A. Yes. There are organic silicates.

Q. What is the nature of those, generally?

A. Well, one of them is ethyl ortho-silicate which is a liquid, and boils around 160 to 170 degrees Centigrade.

Q. I believe I asked Dr. Willard, plaintiff's chemical expert, as to whether he would consider ethyl silicate presumably the same or a similar organic silicate capable of functioning as a flux in a manner called for by the patent, and he said no. Would you agree with that opinion?

A. Absolutely.

Q. Would it make any difference even if you added one to eight per cent of alumina?

A. No.

1773 Q. Will you refer now to the discussion of this composition of the patent found in the first column on page 2 beginning in the next to the last paragraph.

A. Would you just—

Q. First of all note the statement—

A. Would you repeat the question, please?

Q. I am just calling your attention to page 2, column 1.

A. Yes.

Q. Beginning with the next to the last paragraph.

A. Yes.

Q. Note the statement there:

"The composition of the welding medium is of the utmost importance."

A. Yes.

Q. Do you agree with that statement from your study of these compositions described?

A. Yes.

Q. The patent specification then continues with the statement on the part of the patentees:

"We have used calcium silicate and silicates of sodium, barium, iron, manganese, cobalt, magnesium, nickel 1774 and aluminum, both in binary and ternary combinations . . . ."

What is meant in that context by the term "binary combination"?

A. Binary means two. That is, there are two constituents. I interpret that to mean that it is calcium silicate plus silicate of sodium, silicate of barium—

Q. Or one of the others named?

A. Or one of the others.

Q. Similarly, what do you understand is meant by the use of this language, "ternary combination"?

A. That would be calcium silicate plus any one of the pairs of silicates following.

Q. You mean a silicate of any two of the others?

A. Yes.

Q. Combined with calcium silicate?

A. Yes.

Q. Is there any indication given as to the proportions or relations of these different silicates thus combined in binary or ternary groups with calcium silicate in the patent, that you can find?

A. No.

Q. It is further stated in this paragraph, in column 2 on page 2 of the patent—

1775 A. I would like to correct my answer. I have found a statement in column 2, page 2, where it states, for instance:

"Basic materials other than lime of magnesia, for example oxides of manganese, titanium, or the alkaline metals, and known fluxing agents such as borax or boric acid, may be added in moderate amounts . . . ."

Q. "In moderate amounts"?

A. Yes.

Q. To that extent?

A. Yes.

Q. Certain of these are indicated as possibly being associated with calcium silicate, is that right, or calcium oxide?

A. Yes.

Q. What would you understand to be the meaning of the term "in moderate amounts" in this connotation?

A. Well, that is a very indefinite term. It would all depend on the—the term "moderate" depends upon the connotation. In other words, in this case I would think a few per cent was indicated.

Q. Would you consider that the substitution for the basic ingredient calcium oxide or magnesium oxide

1776 of substantially all manganese oxide would comply with that instruction?

A. No.

Q. Referring back again to the paragraph we were pre-

viously discussing, the one at the bottom of column 1, page 2 of the patent, it is stated there:

"We have also used calcium titanate and various titano-silicates . . . ."

Is there any indication anywhere in the patent as to the proportion in which those might be used?

A. The same reference that I have given in the next column says:

"Basic materials other than lime or magnesia, for example oxides of manganese, titanium . . . ."

Q. Titanium is included there, but again in what proportion?

A. Titanium is not a basic material.

Q. But assuming that that is what was intended, that is indefinite from the patent teaching, is it not?

A. Yes.

Q. Assuming that was nitended, what is the amount
1777 it is suggested only may be used?

A. Moderate amounts.

Q. And you would make the same qualification as to the meaning of "moderate amounts" here as before?

A. Yes.

Q. What is clay, Doctor?

A. It is an alumino-silicate hydrated.

1778 Q. Does it contain any other silicate as it occurs in nature? It is a naturally occurring compound?

A. Yes, because it has different sources of—clay is usually obtained in nature through a process such as in glaciation, in which felspathic rocks, silicate rocks, are ground very fine and then after thousands of years they become hydrated, with the net result you may have, besides the commonly described clay alumino silicates—you may have in there all sorts of minerals.

Q. Would this include other silicates?

A. Yes.

Q. Metallic silicates?

A. Yes.

Q. You speak of it as hydrated. What does that imply?

A. It implies in the condition it is found in earth that it has water in it.

Q. What is one familiar commercial industrial use of this clay, pure or with admixtures of other silicates, as you have described?

A. In ceramics.

1779 Q. What does the ceramic industry include? You were speaking of porcelain a little while ago. Has it any more common use?

A. Bricks. Pottery. Dishes. Pipe.

Q. Tile?

A. Tile.

Q. Those are all clay products?

A. Yes.

Q. In their manufacture what happens to the water, the water of hydration, I believe you said?

A. The water of hydration is driven off during the process and the clay shrinks, and if the temperature is raised high enough it sinters together to form a firm bond such as in the case of these very hard paving bricks.

Q. These are vitrified clay products?

A. Vitrified, yes.

Q. They would contain no water?

A. No.

Q. They would be fused metallic silicates or compounds of that nature, would they not?

A. Yes.

Q. Would you consider, without test or experimentation, that ground brick or vitrified brick or tile
1780 would be usable as a silicate called for by this patent?

A. Well, that is something I cannot answer, because of the fact I do not know the analysis of the ground brick. It might coincide with this and it might not.

Q. You used the term "frit" I believe in describing some of these industrial forms of metal silicates used in the ceramic industry more especially?

A. Yes.

Q. What does the word "frit" mean, in the sense in which you have used it?

A. It is obtained by quenching the fused silicate, usually into water, but any way of cooling it suddenly, such as on a chill plate, is effective, so as to maintain it in the glassy state.

Q. Are the materials here in evidence, the several forms of the Plaintiff's so-called Unionmelt and
1781 Lincolnweld 660 flux, properly describable as frits?

A. Yes, sir.

Q. And in their appearance and general character, are they the same as the ceramic frits?

A. They are less complicated, but in general they are the same thing.

Q. Now you have spoken, I believe, of the impossibility, without test or experimentation, of determining whether or not any of the great variety of silicates available in nature, and from industrial sources, would be usable as a welding composition, such as called for by the patent in suit.

Have you tested any specific silicates,—metallic silicates, I mean, of course?

A. Yes, sir.

Q. Will you please name some one which you have thus tested, and which you have found unsuitable?

A. Looking over the statements in the patent, I concluded that a silicate which would be nearest in weight and nearest in formula, would a silicate of a divalent metal, that is, copper silicate.

Q. Copper?

A. Copper, or cupric silicate. So I took cupric
1782 silicate, which also had a ratio, that is, a stoichiometric ratio, as was described here the other day, about the same as Example No. 3 in the patent.

In one case I mixed with that, one ounce of calcium fluoride per pound of copper silicate, and ran a weld, using a current, with an automatic Lincoln machine, of 600 amperes, and 30 volts, at 12 inches per minute.

In that case the surface of the weld had copper on it, as you could see; the copper content was plainly visible.

Also, there were transverse cracks, that is, at right angles to the line of the weld.

Q. Without further inspection or test, what was your conclusion as to the suitability of this copper silicate as a fluxing agent in a process such as we are here concerned with?

A. It would not be suitable.

Q. I think we asked Dr. Willard as to whether ferric silicate would be suitable.

Have you made any tests with respect to that compound?

A. Yes, sir, I have. I made two tests, as I did in
1783 the case of the copper silicate.

In one case I added one ounce of calcium fluoride per pound of ferric silicate, and carried on the welding with the automatic machine, under exactly the same conditions as have previously been described.

That gave a rumpled surface, with slag inclusions along the edges.

Q. Did that produce or give you what you considered to be a satisfactory weld?

A. No.

Q. Now in connection with each of these metallic silicates which you have named, you included, I believe, in at least one test of each series of tests, the prescribed admixture of calcium fluoride; is that correct?

A. Yes, sir.

Q. So that you were using there a welding composition, if such it could be called, which comprised a metallic silicate and a calcium fluoride; is that correct?

A. Yes, sir.

Q. Similarly, when, as you earlier stated—pardon me just a moment, your Honor.

1784 Similarly referring to your testimony, when you previously discussed the ethyl silicates, the organic silicates with one to eight per cent alumina:

Would that respond to the description of a flux, if such it could be called, comprising a silicate, and one to eight per cent alumina?

A. Well, it would answer the description of a silicate, plus the specified amount of alumina, yes, sir.

Q. The term "silicate" in other words, chemically means either a metal, or an organic silicate; is that correct?

A. Yes, sir.

1785 Q. And that claim, or such a claim or definition, rather, would not distinguish between the two, is that correct?

A. That is true.

Q. Now, have you made a specific test of any other metal silicates in actual welding, to see whether they would work? And, if so, name them.

A. Well, I took a sodium silicate, which is made by fusing sodium carbonate or sodium hydroxide, which is a commercial material used for making water glasses or things of that character.

It had a composition of 25 per cent sodium oxide and 75 per cent silica, in granules. To that I added one ounce of calcium fluoride per pound.

I also carried out a similar test or made a similar mixture, using 5 per cent alumina.

These welds were full of little holes and were, in my opinion, unsatisfactory.

Q. In the case where you thus used this sodium silicate plus calcium fluoride, would that be properly described as a composition, whether suitable for welding or not, that included a metal silicate and calcium fluoride?

1786 A. Yes.

Q. And where you added, instead of the calcium fluoride, alumina to this sodium silicate, would that be properly defined as a composition, whether suitable for welding or not, containing or comprising a silicate and alumina from one to eight per cent?

A. Yes.

Q. Have you had an opportunity to study the 660 flux manufactured and sold by the defendant, Lincoln Electric Company?

A. Yes.

Q. Do you know of what it is composed?

A. Yes.

Q. What is the major constituent?

1787 A. Magnesium silicate.

By Mr. Oberlin:

Q. To what extent is it the major constituent in this 660 flux? I mean, is it just barely the major part?

A. It is a major constituent.

Q. I mean to what extent?

A. The manganese oxide content is nearly 50 per cent.

Q. What would that indicate as to the content of silicate, without necessarily calculating it exactly?

A. I will tell you in a minute. It would be 88.90 per cent.

Q. That is nine-tenths is composed of manganese silicate in the 660 flux?

A. I better make a correction; I was hasty. Between 80 and 90 per cent, would be a better statement.

1788 Q. Now, what other ingredients are there in this 660 flux?

A. There is alumina.

Q. In what amount?

A. Oh, about 1.8 per cent—that varies in different samples—ferric oxide, about 1 per cent; what I call a trace of titanium, about 2.43 per cent; calcium oxide, according to this analysis. I didn't make this analysis.

Q. That was the same analysis used by Dr. Willard—

A. It was supplied.

Q. —I mean Dr. Willard. As I recall, the amount of

alumina and ferric oxide is about the same in this composition?

A. Roughly. They are small.

Q. From your knowledge of the manner in which this flux is compounded, is the ferric oxide there an impurity, or intentionally included?

A. It certainly is an impurity.

Q. How about the alumina, in that small amount?

A. The alumina is certainly an impurity. Both of them come from the manganese ore.

Q. Does either of them have any useful function in the composition, to the best of your knowledge and belief?

1789 A. No.

Q. What about the addition of alumina? Do you consider that, from your study of these welding compositions, it adds anything useful to a composition of this kind?

A. In comparison of the welds when the silicate had calcium fluoride added and when it had alumina added, the welds made with the metal silicate with aluminum added were poorer.

Q. Than when you added just calcium fluoride?

A. Than when you simply added calcium fluoride.

I may say the alumina added and used was fused ground alumina of the highest quality.

Q. How would you define or describe the composition defendants' 660 flux, if you can give it any all-inclusive name or handle?

A. Well, it is essentially an alkaline earth silicate.

Q. I am talking about the 660 flux, Doctor.

A. Oh, excuse me.

Mr. Fowler: We will let the answer stand.

By Mr. Oberlin:

1790 Q. I will ask you to look at the composition of the defendants' composition, not to the patent in suit. We will come back to the patent in suit again.

A. Manganese silicate, plus a small amount of calcium fluoride.

By Mr. Oberlin:

Q. Is the latter present as such in this composition, Doctor?

A. I doubt it. From the work that we have done over a

number of years, with the reaction of calcium fluoride and silicate.

Q. Well, it is your understanding that it enters into the composition of the silicate, the manganese silicate?

A. Yes, it forms a complex fluoxysilicate.

Q. That is, where it is interfused with the other ingredients, as is the manner of formation employed?

A. When the calcium fluoride is mixed with, in this case, manganese ore and silica, and all fired in the electric
1791 furnace at once, the calcium fluoride reacts with the silica and forms the complex compound.

At the same time, the silicon tetrafluoride is evolved.

Formerly it was thought that the reaction of the calcium fluoride with the silica gave a calcium silicate and silicon tetrafluoride. However, we have established, through various investigations, that there is a definite compound formed, the fluoxysilicate, which is the name I have coined for it, lacking a definite term.

Q. You mean you have coined it recently, or is that a term you used in previous discussions?

A. We have used it. It is not a term you find in literature.

Q. I mean it is not a term formed for the purpose of this testimony?

A. No.

Q. Very well.

A. I can show the composition of the product, if it is desired.

Q. I think the description of it by terms more readily understood than the chemical formulas will suffice.

1792 This determination of the constitution or compositions of this sort, was that made in preparation for your testimony in this case?

A. No. This investigation was started in 1924.

Q. In line with your previous work that you have described in your testimony?

A. Oh, yes. I have been working on this for many years.

Q. What is the relative proportion of manganese oxide and silica in defendants', or Lincoln 660 flux?

Q. (Continuing) I don't mean in precise figures, but are they there in exactly combining proportions?

A. No.

Q. To form the silicate?

A. No.

Q. Which is there in larger amounts than would be thus required?

A. (No answer.)

Q. Well, simply, if you have got them, state
1793 whether the manganese oxide or the silica is there in larger amounts?

A. The manganese is there in slightly larger amounts, if I recall it correctly. I better check.

1794 That is, the stoichiometrical ratio is such that there is more manganese in there than there is silica. It is not a one to one ratio. It is about seven to six, roughly.

Q. From your observation of this flux in actual performance—that is, in welding—is there any advantage in having such an excess, if I understand it to be such, of the manganese oxide or manganese?

A. Well, manganese is sometimes added in metallurgical operations in order to toughen steel.

Q. Have you made any observations of the use of this flux in actual welding, as to its effect either in increasing or maintaining the manganese content in the weld, the resulting weld?

A. Yes.

Q. Describe just what was done there, and if there was any other material used for comparative purposes, you may state what that was.

A. Welds were made on a flat plate with the automatic Lincoln welder under these conditions: 850 amperes. 33 volts. 24 inches per minute.

The materials for these welds were taken from a locked room. The Lincoln 660 flux was from a container
1795 labelled: Lincoln 660. 852-D A-4-30, which I was told was a sample that was shared with the plaintiff.

The Unionmelt fine was also from the same locked room labelled—the sample was labelled: Grade 20 U. M. fine, size 20 X down—I suppose it means down—Lot 5562R, and the next one was U. M. Coarse, also from the locked room, U. M. Grade 6, Size OX 200, Lot 5551. Run 306. The rods used in this weld were Lincoln L-60.

1796 Q. Those are bare rods?

A. Bare rods.

Q. Very well.

A. It was a coil, which we reserved especially for these tests?

Q. Now, what were the tests, Doctor; that is, what was the nature of the tests?

A. Well, it was found that the Lincolnweld, the manganese content of the weld was increased; that is, the weld had a higher manganese content than the plate, or than the rods.

In the case of the Unionmelt welds, both the fine and the coarse, the manganese content of the weld was lower than the manganese content of the rods, or the plate.

Q. Have you preserved the plate that was thus welded, in part using Lincoln 660 flux, and in part using Unionmelt flux?

A. Yes.

Q. And then likewise the weld rods?

A. Yes, sir, the weld rods are right there also.

Q. (Continuing) Which were used in performing the welding operations which you have previously described?

1797 A. Yes, sir.

Mr. Oberlin: At this time, may it please the Court, I offer the plate which has just been identified by the witness as Defendants' Exhibit No. 132.

I offer the weld rods, consisting of three pieces, attached to a common plate, bearing the marks "Lincoln 680", and the date of 11/29/46, as Defendants' Exhibit No. 133.

The Court: Is there any objection?

Mr. Wolfe: No objection.

The Court: Admitted.

(Whereupon the said articles were marked respectively DEFENDANTS' EXHIBITS 132 and 133 and admitted in evidence.)

The Court: Let me see them.

Mr. Oberlin: Yes, your Honor.

By Mr. Oberlin:

Q. There are drill marks in the welds, in the first of these exhibits, and also in the electrodes.

How do they happen to be there, Doctor?

A. Those were made in order to obtain samples for

1798 analysis.

Mr. Oberlin: The purpose, I may state, your Honor, of putting these in evidence is so that, if plaintiff desires, it can confirm the analyses just stated by the witness.

There is no other purpose, as I am presently advised.

1800 Q. Has the inclusion of this 660 Lincolnweld flux of manganese in the form of manganese oxide or the silicate resulting from the preparation of the flux a definite function so far as you observed from the use of the flux in actual welding?

A. From my experiments it is clear that the use of manganese silicate in large amounts both prevents the loss of manganese from the weld and actually increases the amount of manganese in the weld.

Q. Is that borne out by the tests that you have explained and shown in these exhibits?

A. Yes.

Q. Is manganese, Doctor, an alkaline earth metal?

A. No.

Q. Will you explain first of all, referring to
1801 the periodic table or other established classifications of the elements, the reason for your answer.

A. The first reason I should like to give is based on the definition of an alkaline earth. May I read from a book by J. R. Partington, Fourth Edition, a textbook of inorganic chemistry for University students; this is used in graduate study in inorganic chemistry and has gone through many editions and is sound:

"The older chemists gave the name 'earth' to all non-metallic substances insoluble in water and unchanged by fire."

The point "unchanged by fire" is the important point.

"Lime and magnesia were found to have an alkaline reaction, and were called alkaline earths, the name being afterwards applied to baryta"—which is barium oxide—"and strontia", which is strontium oxide.

Q. All right. Now I suggest Doctor, that you might refer also to the established or well known tables specifying the elements with respect to the relationship or lack of relationship between these two.

1802 A. The original table of Mendeleeff in 1869, was soon modified. It is shown on page 27, a page from Fritz Ephrlam's Inorganic Chemistry.

In this table you will notice that calcium——

Q. Pardon me, Doctor. How is it identified on the table?

A. I have ringed calcium with a black pencil; and over to the right, manganese, the symbol Mn, is also ringed in black pencil.

Calcium is in Group 2, and manganese is in Group 7.

This table did not show completely the differences and similarities.

On the next page, page 28, is what is called an expanded table, in which the series are given their normal full length.

Again you will notice that calcium is in Group 2, and manganese is in Group 7.

Q. And these elements have been indicated by their symbols; in the case of calcium, Ca, and in the case of manganese, Mn?

A. Yes, sir, and they are also ringed, for easy identification.

1803 Q. Yes.

A. On the next page—

Q. Page 29?

A. Page 29.

Q. Yes?

A. —is a still newer table, which shows the increase in electronegativity, or acidigenic properties, as we go from left to right.

Calcium is in Group 2, on the left side, and as we go from that on five spaces toward the acidigenic properties, we come to manganese.

None of these tables show the fundamental differences. This is suggested in the table on page 25. This is a still more improved periodic table.

On this page you will see, to the left, right here, Ca, which is calcium.

Q. And have you ringed that, again, or will you do so, please?

A. I have put an arrow on there.

Q. An arrow?

A. Yes, sir, so as not to obscure it.

Q. Very well.

A. Over to the right is manganese. Now you will 1804 notice that there are lines connecting the elements which are similar.

You will notice that there is a line from magnesium to calcium, and then right on down to strontium, and to barium, and to radium.

Q. And those are indicated by their symbols in each instance, are they?

A. Indicated by Mg Ca Sr Ba and Ra.

Q. Yes.

A. Now you will notice also that manganese is in the middle of a series of elements which are shown in a frame. This distinguishes the type of element, which is within that frame, from calcium, which is not in any frame.

In a study of atomic structure, Bohr discovered that there are four fundamental types of atoms. There is the first type of four, which has a completed shell, and will not react with anything.

The second type, of which calcium is a member, has one incomplete shell of electrons on the outside.

I am very sorry, your Honor, that this shows rather poorly here.

1805 Q. Do they have—pardon me. Go ahead.

A. Manganese is the third type, an entirely different type of structured atom from the calcium.

Mr. Oberlin: I offer in evidence at this time, your Honor, the group of pages referred to by the witness from Fritz Ephraim's Inorganic Chemistry.

The Court: Is there any objection?

Mr. Wolfe: No objection.

The Court: Admitted.

Mr. Oberlin: As Defendants' Exhibit 134, collectively.

(Whereupon said documents were marked DEFENDANTS' EXHIBIT 134 and admitted in evidence.)

By Mr. Oberlin:

Q. Have you yourself, personally, given some thought or study to this matter of classification of elements, Doctor?

A. Yes, I have. It has been one of my great interests and I finally had the courage to produce a periodic design of my own.

Q. Based on Bohr's Table?

A. Based on the Atomic structure entirely and
1806 atomic numbers, and indicating the types of Bohr atoms. In this table the relations of the elements to other elements are shown.

Q. Is that showing substantially in accord with the last table that you called the Court's attention to in the previous exhibit?

A. It is based on the same principle, of showing the four fundamental types of atoms according to their internal structure which makes them definitely different.

Q. This is a photostatic copy of the table as you have thus somewhat elaborated it?

A. Yes.

Q. Will you mark on that similarly the two elements we are here concerned with, namely calcium and manganese?

A. I will mark in red on here calcium and in green manganese. Now we see here again the close resemblances of calcium to magnesium above it, to strontium, barium and radium below. The solid lines show the definite strong resemblances.

If we go over to manganese we see the resemblances of manganese shown in resembling chlorine in certain
1807 of its compounds as shown by dotted lines. We see also that manganese is within a double circle to indicate, as the chart shows up here (indicating) the type of element in which two groups are incomplete, that is, two electron groups; while calcium being within a single circle belongs in the group in which one electron group is incomplete.

The fundamental differences in the behavior of calcium and manganese lie within the difference of the structure as indicated by these two types.

Q. This chart, Doctor, that you have just been describing was published by yourself and its coauthor some time ago?

A. It was published in the Journal of Chemical Education in March, 1945, and has been adopted for publication already in some elementary texts.

Q. It has no relation to our preparation or your study of the patent in suit for this case?

A. Oh, no. This was long before that.

Q. It was independent research work?

A. Yes.

Mr. Oberlin: I offer the chart in evidence as Defendants' Exhibit 135.

1808 Mr. Wolfe: No objection.

The Court: It may be admitted.

(Whereupon said chart was marked DEFENDANTS' EXHIBIT NO. 135 and admitted in evidence.)

By Mr. Oberlin:

Q. Now, you have spoken of the difference between the element calcium and the element manganese as it appears on this chart and as represented by the differences in rings

which indicate a different condition in the electron groups present.

A. Yes.

Q. Has that any actual significance in the behavior of those compounds?

A. Yes.

Q. Or elements?

A. Yes. Calcium, on account of the fact that the electron group in the second outermost ring is 8 and complete, and in the outer is only 2, always has a valence of 2.

On the other hand, manganese—I have this here, if you want this,—

(Handing document to Mr. Oberlin.)

—as shown on page 954 from Partington's Inorganic
1809 Chemistry has an electron grouping which is quite different.

This is the manganese ion which has lost the two electrons. This ion in the electron ring below it instead of having 8 has 2, 4, and 5, which makes 13. 8 is a stable grouping. This permits manganese to exhibit various valences and it makes it so that manganese fundamentally is an entirely different type of element.

Any resemblances of manganese to calcium is entirely superficial.

Q. What happens when manganous oxide is heated in air, Doctor?

A. When any manganese oxide is heated in air it changes over to another oxide. May I read again from Partington's textbook of Inorganic Chemistry, page 947. I regret there is no photostat of this.

This concerns the action of heat on the oxide Mn_3O_4 known as red oxide of manganese.

1810 "It is formed when any other oxide of manganese is heated strongly in air. At lower temperatures manganese trioxide or Mn_2O_3 is formed. Manganous oxide will not persist when heated in air to any temperature as far as known."

Q. What does that indicate, in the case of 660 flux its inclusion in predominating or major portions of manganese silicate, in the behavior of the compound under welding conditions?

A. It is shown by analysis that there is available oxygen, which indicates the presence of higher valence manganese in that mixture, 660 flux.

What the action is at the high temperature of the arc and in the presence of the reducing material, iron, is not so clear.

At that high temperature, it is likely that the manganese would reduce the silicate—I mean the iron would reduce the manganese silicate and liberate manganese, as shown by the analysis of these plates.

Q. In the operation of welding, using this 660 flux, will the manganese, in whatever form it is present in the
1811 flux, be capable of acting as a reducing agent?

A. Yes, it is a reducing agent. If you take manganous silicate formed at room temperature, by the addition of pure sodium metasilicate to manganese chloride you will have a precipitate of manganese silicate.

This is a pink color, if there is no oxygen in the water used. As soon as it is exposed to the oxygen of the air, it begins to take up oxygen, as shown by its darkening, until it finally becomes quite brown.

This is the color exhibited by higher oxides of manganese.

Q. Will calcium silicate or calcium oxide, in whatever form it is combined in the plaintiff's Unionmelt No. 20 flux, have any such reducing action, Doctor?

1812 Q. I think you misunderstood the question. My question is, you have described in the 660 flux the presence or inclusion of manganese silicate or manganese oxide, in whatever form combined, that it is capable of acting as a reducing agent.

Now, in the case of plaintiff's Unionmelt No. 20 flux—and you have seen it in operation and seen its analysis—is there any similar reducing action by the calcium silicate or calcium oxide present?

A. None by the calcium silicate or calcium oxide. It has only one valence, one standard valence.

Q. Is that a fundamental characteristic between the calcium oxide and manganese oxide employed in these respective compositions?

A. Yes.

Mr. Oberlin: You may cross-examine.

1813 *Cross-Examination by Mr. Wolfe.*

Q. Dr. Booth, you know Dr. Willard personally, do you not?

A. Yes, I do.

Q. Have known him quite a number of years?

A. Yes, I have.

Q. And know him by professional reputation as well?

A. Yes.

Q. And he is a chemist and scientist of high standing and reputation, is he not?

A. Yes. I have great admiration for Dr. Willard.

Q. Have you had any experience, Dr. Booth, with electrolysis of silicate melts?

A. No.

Q. When did you first see any—

A. May I ask a question: you mean pure silicate melt?

Q. Yes, or substantally so.

When did you first have an opportunity to see any welding done with this Lincoln 660 flux?

A. Do you want the exact day?

Q. Approximately.

A. It was the last of November, as I remember it,

1814 1946.

Q. So that you had about a month or so, six weeks, to study the matter?

A. Yes.

Q. How many welds have you seen made with this Lincoln flux?

A. I couldn't give you the exact number. I would say two or three dozen.

Q. Those were made in the laboratory of the Lincoln Electric Company, I suppose?

A. Well, they were made on a regular machine of the continuous type, continuous-line welding type, which is in the experimental shop, I think you would call it, or laboratory.

I have also seen it in their plant, I may say, too.

Q. You saw it in regular commercial production in their plant?

A. Yes.

Q. Have you seen the Lincoln flux made?

A. Yes, I have.

Q. Where did you see that?

A. At the Lincoln Electric plant in Cleveland.

Q. And how many opportunities did you have to
1815 see it then?

A. I was there once; and I watched the operation for some time.

Q. And that was an electric furnace operation, was it?

A. Yes.

Q. Now, you mentioned some attempts that you had made to weld with some various silicates; I think you mentioned copper or cupric silicate, and ferric silicate, and sodium silicate; is that right?

A. Yes.

Q. You made an attempt at one weld with each of those, did you?

A. Yes, that is right. Now, wait, maybe I don't understand your question.

Q. Well, I want to know how many welds you made.

A. Oh, we tried it several times, each one.

Q. You tried it several times?

A. Oh, yes.

Q. Under varying conditions, or the same conditions?

A. Same conditions.

Q. What did you try to weld, mild steel plate?

A. I was told it was mild steel plate.

Q. And you didn't try welding any other metals?
1816 A. Than iron or steel?

Q. Yes.

A. No.

Q. And you didn't try any variations in the welding rod?

A. No, it was the same welding rod that we had reserved for that purpose, which I have described before.

Q. You wouldn't be able to say exactly whether or not this cupric weld you spoke of would be suitable for welding bronze?

A. No, I couldn't say, because I didn't try it.

Q. Now, you found, from your observations, I believe you said, of the use of the Lincoln flux, that it resulted in some manganese in the completed weld.

A. Yes.

Q. What percentage did you find?

A. The percentage of manganese—do you wish the complete statement, sir?

Q. Yes.

1817 A. (Continuing) —in the rods, was .53 per cent; and in the plate .47 per cent.

After welding with U. M., Coarse, the bead had a manganese content of .3 per cent, and with U. M. Fine, .29, as close as you can check experimentally.

On the other hand, with Lincolnweld, it was .67, which was .14 more than the rods and .20 more than the plate.

The U. M. Coarse weld was .17 less than the plate and .23 less than the rods, and the U. M. Fine was approximately the same.

There was only .001 per cent of difference.

Q. Did you make any determination, using Unionmelt No. 90?

A. No.

Q. The effect of the small addition of manganese to the weld metal, or the small increase in it, is to improve the properties of the weld metal, at least in some respects, is it not?

A. Manganese is used to toughen steel, and as a deoxidizer.

Q. Now you spoke of adding some alumina to some

1818 Lincolnweld 660 flux, and you said you used a high grade of fused alumina—is that correct?

A. Yes, sir. The reason for that was that you stipulated —or rather, I mean to say, it was stipulated in the patent, that moisture should be absent.

This was a fused electric furnace product, which certainly had no moisture in it.

Q. What did you do with the alumina; just mix is in mechanically—

A. It was ground in.

Q. With the flux?

A. It was ground in.

Q. You did not fuse it in?

A. No.

Q. Now, on this matter of alkaline earth metals; you have not found complete uniformity among treatises and books in the chemistry field as to just what materials are classified as the alkaline earths, have you?

A. In the earlier days, magnesium and even beryllium were included among the alkaline earth metals.

When the structure of those elements became apparent—

1819 Q. Well now just a moment, please, Doctor. Let us just stick to our particular point here, please.

A. I am sorry.

Q. In various tests, you do find different metals which are listed, do you not?

A. The different metals that you find, are in the older texts, with magnesium and berryllium included with calcium, strontium and barium.

Of course, in the older times, radium was not known.

Q. But even at the present time there is not a complete uniformity in all of the texts with respect to that, is there?

A. I have seen some recent texts, and it is my opinion that it is an error to include magnesium and beryllium, because of their greater resemblance to zinc. They are members of Group 2, and it is an error to include them with calcium, strontium and barium.

Q. So that when you say that you do not think that manganese should be classed as an alkaline earth metal, that is primarily just your opinion as to how it should be classified, is it not?

A. No, sir, it is the opinion in all of the books.

1820 I have never seen a book in which manganese is included as an alkaline earth metal, and by the definition which is given for an alkaline earth metal, it cannot be so included.

Q. The definition in what?

A. With an alkaline earth metal.

Q. No, no. In what, Doctor?

A. Pardon me?

Q. I want to know where the definition is which you are now talking about.

A. Well, this particular definition is the one I read, from Partington; but you can find it in other works also.

Q. Now you referred, Doctor, to a periodic table here. Will you please look with me at the first one, I think on page 27 of the Fritz Ephraim book—is that correct?

A. Yes, sir.

Q. In Column 7 of that table, Doctor, there are some other elements listed there with manganese.

Will you please identify those for us.

A. There is masurium, manganese, and rhenium—and manganese, masurium and rhenium are in the same frame; fluorine, chlorine, bromine, iodine, and ekaiodine,—

1821 which latter has not been discovered as yet.

Q. Now as to all of those other elements in that

group, it is a fact, is it not, that none of them except manganese, when present with a valence of 2, are capable of combining with silica as basic elements?

A. I think rhenium would.

Q. You think rhenium would?

A. Yes, sir.

Q. Have you ever made a test to verify that, Doctor?

A. No, sir, I have not, because it is not a very common element.

Q. So that if is just a matter of surmise, as far as you are concerned, is it?

A. No, sir, it is not. It is a matter of expectation, from its structure and position.

Q. Is it not a fact that manganese, with a valence of 2, resembles in this respect, that is, in its ability to act as a basic element with silica, what you have called the alkaline earth metals, more closely than any other member of Group 7?

A. Yes.

1822 Q. How long ago was it known that elements combine in definite proportions?

A. The law of definite composition—well, it must be well over 100 years.

Q. Is it not a fact that the proportions in which the elements combine are called stoichiometric proportions?

A. Yes.

Q. And that law of combination in accordance with stoichiometric proportions was known long before any studies of the shell structure of the atoms wase made, was it not?

A. Yes.

Q. Is it not a fact that the oxide of manganese, MnO is a basic substance in its reaction with silica?

A. Yes. I think you may say that. It is stretching it a little bit.

Q. Is it not a fact that magnesium oxide, MgO is a basic substance in its reaction with silica?

A. That is right.

Q. Is it not a fact that calcium oxide, CaO—

A. That is right.

Q. —is a basic substance in its reaction with silica?

1823 A. And so are a number of metallic oxides that you have not included, such as zinc.

Q. Is it not a fact that in calcium metasilicate $CaSiO_3$, if we wish to replace calcium with manganese in stoichio-

metric proportion, we would use in place of 56 parts of CaO, 71 parts of MnO, the weight of the SiO_2 being the same in both cases?

A. Will you give me time to check up those formula weights, please. I do not remember those things in detail. I think that is approximately right.

Calcium oxide would be 56.08. Manganous oxide would be 70.93.

Q. Approximately 56 and 71 respectively?

A. Yes.

Q. Is it not a fact that calcium, magnesium and bivalent manganese combined with oxygen in such definite proportions that if we know the amount of the element present we also know the amount of the oxygen with which it combines?

A. Yes, providing that is the only element present, manganese and oxygen.

Q. Is it not a fact that it makes no difference in the use of the welding composition whether the calcium fluoride is present in the ionized form or as such, in view of the
1824 fact that the material is molten when used?

A. In my opinion it is not present as calcium fluoride in the flux.

Mr. Wolfe: Let us return to this particular question. I will ask the reporter to read it again for you.

(The question was read.)

A. Well, it is never there as a molecule of calcium fluoride. Calcium fluoride, even in the solid state is ionized. Your question is unanswerable, sir, in technical language.

Mr. Wolfe: Well, let me put it another way:

By Mr. Wolfe:

Q. In so far as you know this welding process in this case, does it make any difference as to the action what the form of the calcium fluoride be properly designated as, in this material?

A. Would you like me to answer that question correctly, exactly?

Q. Yes, indeed.

A. If you add the calcium fluoride at the same time that you make the flux, that is mix them all together and
1825 melt them in the electric furnace with a definite per centage, you will get a different per cent of calcium in equilibrium or in stoichiometric relations with the fluorine than if you made the silicate part, chilled it and added

the calcium fluoride separately; and that is what I understood was stated as one method of procedure in your patent.

Mr. Wolfe: Well, now, I think we are off the track of my inquiry.

By Mr. Wolfe:

Q. What I want to know is whether or not in your opinion it makes any difference in the welding action?

A. Well, I am not a welding expert on that angle.

Q. So you are not able to say as to that?

A. No. I would not want to say on that.

1826 Mr. Wolfe: I have no further questions of Dr. Booth, if your Honor please.

1827 Mr. Oberlin: I have a few further questions on redirect, your Honor.

Redirect Examination by Mr. Oberlin.

Q. Doctor, in connection with the table of elements which you identified as being partly at least of your authorship: Was there an explanatory description of that statement published at the time?

A. Yes, sir. This is a reprint from the Journal of Chemical Education, Volume 22, No. 3, March, 1945, describing this new periodic table.

Q. And the chart that was introduced is an enlargement of the chart that appears in this reprint of the article; is that correct?

A. Yes, sir.

Mr. Oberlin: I ask to have the document, marked as Defendants' Exhibit No. 136, and I offer the same in evidence.

The Court: Is there any objection?

Mr. Wolfe: No objection.

The Court: Admitted.

1828 (Whereupon said document was marked DEFENDANTS' EXHIBIT NO. 136 and admitted in evidence.)

By Mr. Oberlin:

Q. Now, Dr. Booth, have you during the noon recess calculated the relation or proportion of the base ingredient in the Lincoln 660 flux, to the acid, or the silica?

A. Yes, sir.

Q. And what did you find it to be, accurately calculated?

A. I used the analysis that was submitted by Dr. Willard, and found that the ratio of the acid constituents to the base constituents was in the ration of 67 to 78, approximately.

That is not the stoichiometric ratio. There are 11 points of base over the acid ratio, or amount.

In other words, it is a basic flux.

1829 Q. I think you indicated that there were other metals than manganese which, in this one state of oxidation, have two valences?

A. Yes; iron, cobalt, nickel, as examples.

Q. Does this necessarily, when they are in oxide form, make them bases suitable for use in a welding composition?

A. No.

Q. That mere fact would not, in your opinion, have any determinative value in the selection of such an oxide?

A. No.

Mr. Oberlin: That is all.

Mr. Wolfe: No further questions.

(Witness excused.)

Mr. Wolfe: If the Court please, I would like to make an inquiry from the defendants. They furnished me this morning with a copy of the Lincoln Company's Weld Directory which lists, on page 15, a Fleetweld rod No. 11, apparently the same one that was used in the first demonstration yesterday; but I haven't been able to find the

1830 type listed as used in the second demonstration.

Mr. Stewart: The second one is not in any publication. It is on the market, but is not listed in any publication yet.

Mr. Wolfe: This Lincoln LH-7—

Mr. Stewart: Is the latest series of what is known as hot rods.

Mr. Wolfe: Is there anyone who can tell us what that coating is supposed to be?

Mr. Stewart: There is only one man who knows what that coating is, and that is the head of that department. They are not patented, and the way they are put together is not generally known.

Mr. Wolfe: It is a matter of trade secrecy?

Mr. Stewart: Yes. The analysis of the coating, you, of course, can make that by taking the coatings off of the rods. We can supply these rods to you, if you like.

Mr. Wolfe: We can't make it in a hurry. I understood yesterday these were some well known rods.

1831 Mr. Stewart: I had thought so myself.

Mr. Wolfe: We may want to make some further objection about that later, your Honor. It just came to my attention, the peculiar situation on that rod.

Mr. Cahill: There was an offer here of correspondence between Mr. Lincoln and Mr. Cornwell. I don't know whether this is a convenient time to take it up.

The Court: You mean it was a reserved question?

Mr. Cahill: It was reserved for the purpose of giving me an opportunity to look at the correspondence; and I have had a chance to look at it, since it was brought up, and I do object to it.

The correspondence in part has no possible bearing on the controversy here. The subject-matter isnt anything but "Are you coming to New York," or "I will see you in Cleveland," something like that.

The second general category has to do with very many self-serving declarations. I will speak as to Mr.

1832 Lincoln's part of the correspondence.

The third has to do with a large number of hearsay declarations by Mr. Lincoln as to what he has said or has heard, and the final part of the correspondence has to do with letters containing both hearsay and self-serving declarations, and written after thi. lawsuit was brought.

So on all those grounds, I object to any part of it being admitted.

Mr. Oberlin: A portion of the correspondence was introduced, and can only be understood if the whole set is before you. It is not an extensive pile, the letters exchanged between Mr. Lincoln as head of Lincoln Electric Company, and Mr. Cornwell as head of the Unionmelt Division of the plaintiff, Linde Air Products Company.

While there may be some irrelevant matters like, "When will you be in New York," or "When will you be in Cleveland," I think the simplest and most proper way to present the complete picture is to have the entire file. It is

1833 not a long list, or a large file.

Mr. Cahill: The only correspondence introduced was a single letter which I put in, on the cross-examination of Mr. Lincoln. I did it only after asking him had he sought a license under the Jones patent. When he denied that, I put that letter in by way of impeachment.

Again I say the admission of an instrument by way of

admission does not justify the admission of other instruments on redirect examination that have no connection, and where the adversary or the writer may involve Mr. Lincoln or Mr. Cornwell; and—

Mr. Stewart: Well, the—

Mr. Cahill: May I finish my statement?

Mr. Stewart: Yes.

Mr. Cahill: These documents are replete with what Mr. Lincoln said he had heard.

1834 The Court: Let me ask you this: If the purpose of putting this in is to explain or give the background leading up to this one letter which you put in, if those objectionable parts can be eliminated by reading the other parts into the record, rather than making them exhibits and submitting them to the Court, do you have any objection?

Mr. Cahill: If counsel can cull out physically what he thinks is admissible under the limitations laid down by your Honor, I would be very glad to consider it; but this mass offer that is made here of this entire file permits of no such ready selection.

It is, as I say, the entire file of correspondence between these two men, and is interlarded with the kind of objectionable material I have described.

If counsel wishes to make that selection, I will be glad to give it consideration.

The Court: Do you think hearsay statements would be admissible here even though they are contained in correspondence which may have led up to this one letter?

1835 Mr. Oberlin: May I answer some of the comments which counsel for Plaintiff has made, your Honor?

The Court: Yes.

Mr. Oberlin: First of all, the impeachment attempted to be made by the production of this letter is not successful, even on the face of the document, the letter and attached proposed form of cross-license agreement. That does not establish, clearly does not establish that Mr. Lincoln was seeking a license. At least, it was to be understood in connection with the whole proposition.

That whole proposition was developed in the correspondence which preceded and is illustrated or explained in the correspondence which followed.

The character of the negotiations, if you can call them negotiations, was highly informal, the negotiations that proceeded during this period beginning—this file contains

letters beginning back in 1941 and concluding in 1945. Some of the irrelevant matters like telegrams or what-not seeking an appointment on the part of one party or
1836 the other might well be eliminated, and I think we could condense the file to that extent.

The Court: While it might not be as self-explanatory as otherwise, could you eliminate the so-called statements, if there are such, which are purely hearsay? In other words, what somebody else has said regarding these different things.

Mr. Oberlin: The gist of it is this, if I may explain just briefly, your Honor: Apparently Mr. Lincoln was seeking to secure from Plaintiff through its head, the head in charge of this particular division that was exploiting Unionmelt, a statement regarding its patent claims.

That was, as indicated here in this correspondence, occasioned by representations being made to the trade—

Mr. Cahill: That I object to. That is trying to get before the Court the hearsay declarations to which I have objected, because that is exactly the vice of the corre-
1837 spondence and Mr. Oberlin is giving a graphic illustration of that vice.

He is about to speak of representations Lincoln says he heard in the trade. That is just what I objected to, and that is why I objected to Mr. Oberlin finishing.

The Court: I think what I will do is this: I think rather than to admit this and perhaps to let in a lot of what otherwise might not be admissible evidence, I will permit you to attempt to condense this correspondence and eliminate anything objectionable; and then after you have made the condensation and the Plaintiffs have had the benefit of checking it, in order to place this letter in whatever context it should be, its admissibility can be ruled on.

Mr. Oberlin: I think it should be given that context. We will endeavor to have such at hand for presentation to the Court tomorrow morning.

The Court: Very well.

Mr. Oberlin: We will attempt to review it with
1838 counsel beforehand, if that be possible. This is the file.

(Handing file to Mr. Fowler.)

I next desire, if your Honor please, to read certain excerpts, constituting the major portion of the deposition of James Morrison Keir, a witness called by the Defendants for the purpose of adverse party examination.

This deposition was taken in New York City, under date

of Friday, August 22, 1946, beginning at 10:30 a. m., before a Notary Public, duly authorized, as evidenced by the certificate attached.

I am reading from my copy, which I believe to be a true copy.

The witness was duly sworn, and then deposed and testified as follows:

"By Mr. Oberlin:

"Q. Your name is James Morrison Keir?

"A. Yes, sir.

"Q. Your age?

"A. Sixty.

"Q. Residence?

"A. 806 Bronx River Road, Bronxville.

1839 "Q. And present occupation?

"A. Welding manager, you might say.

"Q. Are you an employee or officer of the Plaintiff in this case, the Linde Air Products Company?

"A. Employee.

"Q. In what capacity, your official title, if any?

"A. Well, I bear the title of Unionmelt Manager of Service and Development.

"Q. How long have you been working in this particular capacity or with this particular title?

"A. Oh, I probably was acting as such before the title was conferred upon me. I presume I may have been acting as such from somewhere about 1936, 1937, something like that.

"Q. In other words, you have been connected with this Unionmelt project or division as I believe it is now called, of The Linde Company practically since the inception thereof?

"A. Yes.

"Q. Which dates back to 1936 or thereabouts?

1840 "A. Yes.

"Q. What was your employment prior to coming with The Linde Company?

"A. Well, I was also employed with the same corporation, and my entering the employ of The Linde Air Products Company required a transfer from an affiliated company.

"Q. That is the Oxweld Acetylene Company?

"A. No, the Union Carbide and Carbon Research Laboratories.

"Q. Were you ever connected with Oxweld Acetyline Company, another subsidiary, I believe, of Union Carbide?

"A. Not as an employee.

"Q. You did take out some patents which were assigned to that company, I believe?

"A. It may have been.

"These various subsidiaries, including the holding or parent company, we called in the course of our examination of Mr. Cornwell yesterday, the System, and I may use that word meaning inclusively any or all of them.

1841 "A. What was the word, please?

"Q. System S-y-s-t-e-m.

"A. Oh, yes, System.

"Q. It is rather difficult to distinguish between the activities of the several subsidiaries even in this welding field. You have an engineering training or background, Mr. Keir?

"A. Yes.

"Q. What was your schooling?

"A. Well, I was a graduate from Baldwin Wallace College.

"Q. That is near Cleveland?

"A. Yes, and from Case School of Applied Science.

"Q. What was your year, plase?

"A. 1918.

"Q. With what degree?

"A. Chemical engineering.

"Q. Have you had any special training in electrical engineering apart from chemical engineering?

"A. Not particularly.

1842 "Q. You regard yourself, then, rather as a chemist or chemical engineer rather than an electrical engineer?

"A. Chemical engineering, with some metallurgical training also.

"Q. Well, those two are rather closely associated?

"A. Yes.

"Q. Did you go directly from college to the System, one of the subsidiaries of Union Carbide?

"A. No.

"Q. What were your various employments before you came with Union Carbide or a subsidiary thereof?

"A. I was employed with the Du Pont Company.

"Q. Up until when?

"A. Until January 2, 1919.

"Q. And then?
"A. Or approximately that date.
"Q. And then where did you next find employment?
"A. I became employed by the National Carbon Company at Cleveland.
1843 "Q. That later was acquired by Union Carbide and is now a subsidiary of it?
"A. Yes, only it was acquired previous to that date.
"Q. It was already a subsidiary?
"A. Yes.
"Q. So your employment with Union Carbide or the System began as of that date?
"A. Yes.
"Q. Now, you have spoken of one of the subsidiaries, Union Carbide and Carbon Laboratories, Inc.?
"A. Carbide and Carbon Research Laboratories.
"Q. Give the full name correctly.
"A. Union Carbide and Carbon Research Laboratories, Inc.
"Q. Where does that subsidiary have its principal office and plant, if any?
"A. The laboratories are located in Niagara Falls, New York.
"Q. Does it carry on research work as indicated by its name for all phases of activity of the System?
1844 "A. Not quite. If in the System you include such as the Carbide and Carbon Chemicals it doesn't.
"Q. Or bakelite.
"A. Yes, or National Carbon Company.
"Q. Has it, however, carried on all research work in connection with this Unionmelt Division of The Linde Company?
"A. Yes.
"Q. How long has it had its laboratories in Niagara Falls?
"A. Since the fall of 1934.
"Q. Previously to that the laboratories were located somewhere on Long Island, is that correct?
"A. Yes.
"Q. Where?
"A. Well, it was in Long Island City.
"Q. Have they been removed entirely from there to Niagara Falls?
"A. Yes.
"Q. When did that removal occur, approximately?

"A. It took several months to effect the complete
1845 removal.

"Q. I meant in what year?

"A. Oh, in 1934.

"Q. You were connected with the laboratories when located on Long Island?

"A. Yes.

"Q. And then when removed to Niagara Falls, you followed to Niagara Falls?

"A. At a later date, yes.

"Q. Not immediately?

"A. Not immediately.

"Q. Has the work which the Research Laboratories have done in connection with Linde's Unionmelt Division or project included development or work on the electrical equipment used or rather sold by the Division?

"A. There is really no electrical equipment sold by Linde. All electrical equipment is obtained from other suppliers.

"Q. Well, but they sell it to customers?

1846 "A. The only thing that we sell are the welding heads, if you call that electrical equipment.

"Q. Yes, I would.

"A. All right, that is all we made, are the heads and the control box.

"Q. The work that was done in developing that into a special commercial form, that was done by your laboratories, is that correct, or was it done by some other division or unit of the System?

"A. No, it was done by Linde.

"Q. Independently of the laboratories?

"A. Yes.

"Q. Do you know where that work was carried out?

"A. Well, the development of the equipment was carried out largely at Newark, New Jersey.

"Q. The Linde Company has a plant at Newark?

1847 "A. Yes.

"Q. And that's where that work was carried out?

"A. Yes.

"Q. Did you have anything to do with that work?

"A. Oh, to a certain extent, yes. That was largely mechanical design work.

"Q. And related presently to what you call the welding head?

"A. Yes.

"Q. Not to generators or electrical measuring instruments or the like.

"A. No.

"Q. You have had considerable to do with the so-called Unionmelt flux which is one of the products which Linde sells through this Unionmelt Division, is that correct?

"A. Yes.

"Q. That flux is used in a method of electric welding, is that correct?

"A. Yes.

"Q. Had you anything to do with electric Weld-
1848 ing, any kind of electric welding, before you were called upon to assist in this Unionmelt process?

"A. Well, such as you find in a laboratory that is concerned with welding, I was able to weld with the manual electric welding method, and some gas welding, gas cutting.

"Q. Well, you had some familiarity before you thus became attached or did work for the Unionmelt Division with so-called weld rod or metallic electrodes, did yoo not?

"A. Somewhat, yes.

"Q. Weld rod or metallic electrodes designed for use in electric welding?

"A. Yes.

"Q. More particularly so-called electric arc welding?

"A. Yes.

"Q. You took out some patents on such weld rod or electrodes which were assigned to the Oxweld Acetylene Company?

"A. It was assigned to one of the companies. I just don't remember which one."

I am omitting now approximately one page, going
1849 from the bottom of page 198 of the transcript, to about the middle of page 199:

"Q. You are familiar with the so-called Unionmelt, the composition sold under that name, or as Unionmelt flux, by the Unionmelt Division of Linde?

"A. Yes, I have considerable familiarity with it.

"Q. As I understand, there are several different varieties or at least numbered grades of that flux currently on the market?

"A. Yes.

"Q. Can you list them by number of other trade designation, and, so far as you feel free to do so, indicate the

respective characteristics either in composition, form or special field of use?

"I am speaking now of the present commercial grades.

1850 "A. We have four grades, identified as 20, 70, 80 and 90. The most common probably used is the grade 20 for general work, used for general work. The other compositions are used interchangeably with no very clear-cut distinction for varying thicknesses and compositions, like alloy compositions, and so forth.

"Q. What are the differences between these grades, as far as you can describe?

"A. Well, there are chemical composition differences.

"Q. Are there substantial chemical differences?

"A. In one way you might say substantially, and in another not, because in compositions of that nature a slight change of one element might considerably change its action.

"Q. Are there any other differences, physical, for instance?

"A. No, except probably a slight difference in color.

"Q. How about fineness of the materials? It is a

1851 granular material, I believe, this Unionmelt flux?

"A. Yes, we make each of them in about four different finenesses.

"Q. That is, in addition to the four different grades which you have given these numbers, each is further subdivided into grades or degrees of fineness?

"A. That is correct.

"Q. Are those same gradations as to fineness observed in the case of each of the four numbered grades?

"A. Practically all.

"Q. What are those grades of fineness, how do you identify them?

"A. Well, the coarsest is classified as 8x200 mesh.

"Q. What does that mean?

"A. Well, it means that there is no material coarser than an eighth of an inch included in that, and that there is no material finer than 1/200th part of an inch.

"Q. What is the next grade?

"A. The next grade is 12x200 mesh, and the next is 20x200, and the fourth is 20xD. That includes dust.

1852 In that case there is material finer than 1/200 of an inch.

"Q. And each of these four numbered grades may be

supplied in any one of these four different assortments or degrees of fineness?

"A. That is generally true, although in some cases we have no particular call for these different meshes, and we don't consider them standard.

"Q. Does the flux function differently depending upon the chemical differences that characterize the four numbered grades?

"A. What do you mean by 'function differently'?

"Q. Well, in any respect. You are familiar with the use of these fluxes, of course, in actual operation?

"A. Yes. They may have slight differences in enabling quicker-made welds with higher current densities in one case, and coarser material is generally proved and it makes it easier to make a satisfactory current—"

1853 Mr. Cahill: That should be "weld," I think. I have "current" stricken out.

Mr. Oberlin: I am sorry this copy hasn't been corrected.

"satisfactory weld with lower currents and higher speeds."

The Court: Read it again, please.

Mr. Oberlin: I will read the entire answer:

"They may have slight differences in enabling quicker-made welds with higher current densities in one case, and coarser material is generally proved and it makes it easier to make a satisfactory weld with lower currents and higher speeds. That is the distinction that we make.

"Q. You are speaking now of the further gradation in fineness when you speak of coarser material having a certain characteristic in use?

"A. Well, I mean that coarser material is generally used for low current work, and fine material for higher current work. That is the distinction generally.

1854 "Q. You have anticipated a further question I was going to ask, as to what the difference in the use was of the different grades of fineness of material. How fine is the dust in the grade that is the lowest in that respect or the highest in that respect?

"A. Will you repeat the question, please?

"Q. Yes. How fine is the dust in the grade which you spoke of as having the largest amount of fineness?

"A. Well, I would say that it includes impalpably fine material. I think that expresses what the finest particles

would be—impalpable dust. How much there is of that is difficult to determine.

"Q. Is anything screened out in that?

"A. No.

"Q. What percentage is there of that degree of fineness in that grade?

"A. Well, it may range from 10 to 15 per cent, somewhere in that neighborhood.

"Q. Now we had occasion yesterday, in asking Mr. Cornwell some questions about these different vari-
1855 eties of grades of Unionmelt flux to indicate a desire for samples of the commercial products. How would we identify those in making this request, first by number and then by grade in the matter of fineness so that we can order them if we choose from your company?

"A. Well, you mention the grade.

"Q. Numbered grade?

"A. Yes, and then just the two limits, the upper and lower limit of the sizing, for example."

I omit now from the lower middle part of page 203 of the transcript, through the first seven lines on page 204.

"Q. How do you determine, how does a customer determine which particular flux it should use in connection with a particular welding operation?

"A. Well, some of it may not seem so logical, but largely by their own experience and by experimental attack on the specific problem that they are faced with. They may
try different grades. They may have some in their
1856 stock and they will try the different fineness and establish themselves which they should use and which they should order.

"Q. I suppose either at the laboratory or in some one of these associated companies of The Linde Company in the System there have been run such tests so that you standardize some operations, is that correct?

"A. Yes, that is correct.

"Q. And you have probably issued some general instructions covering that subject?

"A. Yes.

"Q. The selection of the fluxes?

"A. That is right.

"Q. But actually it does require in many cases a test in the field of the flux on a particular job, I mean?

"A. Not necessarily. If it is something that experience covers, then they already know what to use.

"Q. I mean, in many cases, however, they have to make such a test to indicate it?

"A. Well, if there is something very unusual, you
1857 would have to make such a test.

"Q. Were all of these four numbered grades of flux developed simultaneously and placed on the market or were they placed on the market successively?

"A. Successively.

"Q. In the order that you have named them, or what was that order?

"A. 20, 70, I believe then 80 or 70; 70 and 80 were not very far apart. One may have preceded the other. That I don't recall.

"Q. And then 90?

"A. 90.

"Q. 90 was the last?

"A. Yes. That is, it may have been experimented with at a different time, but it only became commercially standard after the others were.

"Q. That is what I meant by my inquiry. Were there other grades, commercial grades, than the four at any time placed on the market by Linde?

"A. I don't recall any.

1858 "Q. Was 20 as it is now marketed the only commercial flux placed on the market when Unionmelt was first promoted?

"A. Yes, with slight changes found by experience, to make slight alterations, but fundamentally it was the same composition.

"Q. And no different number has been applied?

"A. No.

"Q. Then followed 70 and 80?

"A. Yes, 70 and 80.

"Q. How close did they follow 20?

"A. Oh, by several years. You mean in regard to time?

"Q. Time, yes, sir.

"A. Oh, two or three years apart.

"Q. And when did the more recent number 90 go on the market?

"A. Oh, it went on the market probably three years ago. It may be a little less or may be considerably more. That is just my present estimate."

I omit now from the last four lines on page 206 to the

end of page 214 of the transcript, and resume reading
1859 at the top of page 215:

"Q. In addition to your connection with the specifications of the various grades of Unionmelt flux, do you have anything to do with determining specifications for the weld rod or metallic electrode used in connection with the flux in welding operations for the Linde Company?

"A. Yes, I do. They have become largely standard for a number of years and have not required a great deal of alteration or reconsideration.

"Q. Well, I meant at some time or other during this period that we are discussing you did have to do with specifications of the weld rod or electrode?

"A. Yes.

"Q. Has that weld rod been sold by Linde under a trade name, do you know?

"A. It is just identified by number.

"Q. Has not the name Oxweld been applied to it?

"A. Oxweld has been applied also, Oxweld num-
1860 ber so and so.

"Q. Well, Oxweld has been used rather generally to describe this weld rod which has been merchandised by the Linde Company to certain prescribed specifications?

"A. I believe that all the weld rods that are sold by Linde Air Products Company carry the trade title Oxweld.

"Q. And those were special specifications whenever they were determined that were required to be incorporated in this weld rod as made by your suppliers?

"A. Yes."

There were then identified some patents taken out by Mr. Keir, and I resume the reading on page 218, line 7.

"Q. I believe the first three patents—Exhibits 48, 49 and 50 which you have just identified—relate to welding rod and more particularly the composition of welding rod or metallic welded electrode, is that correct?

"A. Will you repeat the question?

"(The pending question was read.)

"A. Yes.

1861 "Q. Does the Oxweld rod which The Linde Company merchandise embody the teaching and specifically the composition of any of these three patents?

"A. No.

"Q. Well, the Oxweld rod does include manganese as an ingredient, does it not?

"A. Yes.

"Q. The amount is ascertainable by analysis so I suppose you will not object to telling us what the percentage is or range of percentage?

"A. One grade is about 1 per cent, another grade has about 2 per cent manganese.

"Q. It is invariably used in the weld rod, manganese, as sold under the name Oxweld for use in the Unionmelt process or with Unionmelt flux, is that correct?

"A. Will you say that again, if you please?

"(The pending question was read by the Reporter.)

"A. The question is a little confusing to me, but if you mean that manganese of that range of composition is 1862 used in the rods that are now used, the answer is yes.

"Q. Was it always so used from the beginning of the commercial exploitation of Unionmelt flux?

"A. There may have been slight changes in the manganese, probably a slight increase in the manganese, but fundamentally it contained about that range of manganese in the rods that we sell.

"Q. How were you introduced, when and under what circumstances, to the Unionmelt project of your company; when did you first hear of any such project of welding?

"A. Oh, probably early in 1934 or—1934, yes.

"Q. Where and under what circumstances? Just relate them fully as you remember them.

"A. I believe my first acquaintanceship with the process was when the equipment and the information from Mr. Cornwell came to the laboratory to proceed with experimenting with the process and becoming familiar with it.

"Q. That was when a certain piece of equipment 1863 was received at the laboratory then located on Long Island, from the West Coast?

"A. That is correct."

I omit six lines on page 220, and continue:

"Q. Was any flux received along with the equipment or subsequently for use with it in these tests?

"A. There may have been a small amount, but I can't answer that question accurately.

"Q. You have no recollection?

"A. I don't recall definitely.

"Q. Do you remember ever receiving any sample of flux from the West Coast for use with this equipment or otherwise?

"A. No.

"Q. Well, you used this equipment in making some tests, I believe you indicated, and in that connection employed flux of some kind?

"A. Yes.

"Q. Where did you obtain the flux, and how?

1864 "A. That may have been made by ourselves.

"Q. Did you have anything to do with the making of it?

"A. No.

"Q. Did you know at the time what its composition was?

"A. In a general way.

"Q. Were any records made of its analysis or other characteristics, of the flux used in these first tests?

"A. There were probably records made at the time.

"Q. Are they still in existence?

"A. I doubt if the analysis would be kept over a period of 12 or 13 years; it is most unlikely.

"Q. They would be in the possession of your laboratory, now removed to Niagara Falls, if they are still in existence?

"A. Yes."

Thereupon a request was made for the production of such records, and it is my recollection that some

1865 analyses or reports dealing with the flux used in those early tests were produced.

Mr. Stewart: No. None were.

Mr. Fowler: Yes, they were.

Mr. Stewart: Oh, yes. You are right. Sorry.

Mr. Cahill: Did you get the answer, Mr. Reporter?

The Reporter: Yes.

Mr. Cahill: "Yes, there were."

Mr. Oberlin: We will attempt to identify and offer those in connection with the deposition. I do not have them present. They were not produced in connection with the deposition; but in response to the request made by counsel subsequently.

I now resume reading on page 226, line 8 from the bottom:

"Q. Were you advised ever of the bringing of a suit under that patent shortly following its issue date against Western Steel & Pipe Company?

"A. What was the question?

"(The pending question was read.)

1866 "A. Well, I don't recall if I was definitely advised. I recall being familiar with the situation.

"Q. Were you consulted at any time in connection with that by your company or any of its officials or counsel? What I mean is, did you have anything to do with the preparation of their case against that company?

"A. No.

1867 "Q. What was the occasion for your visiting Mr. Kennedy's shop whenever it was that you visited it?

"A. It was mostly personal; I would say entirely personal.

"Q. Did he perform any special operations or give any special demonstrations on the occasion of your visit?

"A. No.

"Q. Did he do any welding at all when you called at his shop?

"A. I don't recall seeing any welding.

"Q. It was just a personal call, as you say.

"A. Yes.

"Q. Coming back to this Oxweld rod, what was the reason for including manganese in its composition in the proportion you stated?

"A. Well, to improve its physical properties. Manganese is probably one of the most outstanding elements in regard to ready accessibility and relative cheapness, and in regard to its imparting of good physical properties to steel.

1868 "Q. And when you say 'imparting good physical properties' you are referring to the ultimate weld obtained by the welding operation?

"A. Yes.

"Q. That characteristic of manganese is, of course, well known to metallurgists?

"A. Did you ask me a question?

"(The pending question was read by the Reporter.)

"A. Yes.

"Q. And for many years prior to 1933, say?

"A. Oh, yes.

"Q. I understand your number 90 flux, the last of the series of four that you identified earlier, contains manganese also, is that correct?

"A. Yes.

"Q. Is it there as a metal or as a compound?

"A. No, as a compound.

"Q. What function does it perform there, the same as manganese in the weld rod?

1869 "A. No, not to the same extent.

"Q. Well, in some degree?

"A. Probably to a slight degree, but it affects the physical properties of the Unionmelt itself.

"Q. Does it also have beneficiating effect on the weld obtained?

"A. It probably has some.

"Q. You still, however, continue to use Oxweld rod which contains the indicated percentage of metallic manganese, I take it, even when you use number 90 flux?

"A. Well, not always. We also use other rods of a lower manganese composition.

"Q. When you use number 90 flux?

"A. Occasionally, yes, but not always.

"Q. Did you ever become acquainted with a welding operation carried on by the National Tube Company in its so-called Christy Park plant near Pittsburgh, Mr. Keir?

"A. You mean, by observing it personally?

"Q. Yes.

"A. No.

"Q. You never visited that plant?

1870 "A. No.

"Q. In operation or otherwise?

"A. No.

"Q. All you know about it is what you have seen in the reports, perhaps to officers or other members of your company's staff?

"A. Contact with other people.

"Q. You were one of the representatives of the Plaintiff, I believe, Mr. Keir, at a demonstration, welding demonstration, which was carried out at the plant of the Graver Tank & Mfg. Corporation, or Company, at East Chicago on May 21, last?

"A. Yes.

"Q. Have you seen a collection of photographs and also two reels of movie camera film that was taken of that operation?

"A. No, no.

"Q. Those haven't been shown you?

"A. No.

"Q. You understood when you witnessed that demonstration that the equipment used there was of the manufacture of the Lincoln Electric Company, one of the

1871 Defendants in this suit?.

"A. Yes.

"Q. Likewise that the flux that was used was of its manufacture?

"A. Yes.

"Q. Did you make any observations of the current characteristics of the current used during the welding operation?

"A. What do you mean by 'current characteristics'?

"Q. I mean amperage and voltage.

"A. I did at the time.

"Q. Do you recall what the amperage and current was?

"A. No, I can't clearly recall that.

"Q. Well, did you regard them as in any way unusual in a welding operation?

"A. No.

"Q. The flux in question, as I recall—I was also present—was placed in the form of a layer along the work piece just in advance of where the welding operation was conducted; that is correct, is it not?

1872 "A. Yes.

"Q. Do you recall the depth of that layer of flux, I mean approximately?

"A. Well, it may have been 5/8th of an inch.

"Q. It might have been an inch?

"A. I don't think it was an inch; probably 5/8th.

"Q. How did the depth compare with the practice of your company or of its customers acting under its instructions in carrying out your so-called Unionmelt process?

"A. Well, generally it would probably have been a thicker layer.

"Q. When you use your flux?

"A. Yes.

"Q. That is, as you would prescribe it at least?

"A. Yes.

"Q. Do you know whether your customers actually use it as thick as you prescribe it?

"A. Oh, in some instances they use it much thicker than we prescribe.

"Q. They sometimes use a thinner layer?

1873 "A. Thinner than we prescribe?

"Q. Yes.

"A. Well, our instructions to the user are to use no thicker layer than he feels is necessary. I think that when we give them the layer thickness, I think it is probably the optimum thickness that can be used.

"Q. Well, minimum or maximum?

"A. Well, when I say 'optimum' it is just a happy medium that gives them the best results.

"Q. When you say 'best results' what do you mean?

"A. Well, it gives a good, sound weld, and permits them to make the weld as fast as is required, and contributes all around to the ease and convenience of the operator. All these factors enter into it. When I say 'optimum' they are all included.

"Q. When you say 'ease of the operator' just what do you have in mind specifically?

"A. Well, I would say it is easier for him to adjust the voltage and current and to remain steady during welding.

1874 "Q. There were a number of work pieces welded during this demonstration there at the Graver plant last May, and subsequently they were cut, each pair of plates into two half sections approximately, and one of each forwarded to representatives of The Linde Company for examination.

"Did you have anything to do with the subsequent examination of those plates?

"A. Yes.

"Q. What?

"A. Well, we X-rayed them, the samples that were sent to us we X-rayed, but beyond that we have made no further examination.

"Q. Well there were X-rays made of the plates intact; that is, before they were thus cut in two at the Graver plant, I believe, on that occasion?

"A. Yes.

"Q. You were present when those were taken?

"A. Yes.

1875 "Q. Do you remember X-rays that you have made subsequently indicate any differences in the weld over what those made there show?

"A. I thought that they were a pretty good check.

"Q. The X-ray examination which you made independently showed no essential differences in the character of the weld over those shown by the X-rays taken at the plant?

"A. That is the impression that I have, yes.

"Q. The plates that were welded varied in thickness, I believe, from a half inch to an inch.

"A. I think it was 3/4 and an inch.

"Q. Whatever they were, from such examination as you have made of the welds by X-ray and otherwise, would you call them satisfactory welds?

"A. From external appearance.

"Q. So far as you have examined them they are satisfactory welds?

"A. Yes.

"Q. In the case of all of the plates that were made there?

"A. Yes.

1876 "Q. In the course of the welding demonstration at the Graver plant, did you observe whether any arc was in evidence during the operation of the equipment?

"A. Well, there was a characteristic dazzling light emission.

"Q. That was quite noticeable?

"A. Quite noticeable.

"Q. In the welding of all the plates?

"A. Yes.

"Q. Could you distinguish that from the characteristic light emitted by an arc in a welding operation conducted between a metallic electrode and a metallic work piece?

"A. I don't believe I could do that. I couldn't do that at all.

"Q. You have seen the so-called Unionmelt Process in operation, that is, a welding operation carried out between a metallic electrode and a metallic work piece using a layer of so-called Unionmelt flux, I presume, many times?

"A. Oh, yes.

"Q. You have probably conducted such a weld 1877 operation yourself many times?

"A. Yes.

"Q. At your laboratories?

"A. Yes.

"Q. Do you remember getting an arc in such operation?

"A. Well, if you are careless you get something there that will affect your eyes.

"Q. If you are careless in what way?

"A. In having insufficient melt or no melt there.

"Q. Well, judging from the observations that you have made of the plates, as well as out there at the Graver plant, the presence of the arc that you noticed there did not affect the quality of the weld?

"A. I don't know about the quality of the weld. I have made no physical tests.

"Q. I say, so far as you have made any examinations?

1878 "A. Just visual examinations, superficial.

"Q. You said you have made no physical tests. Has anyone on behalf of The Linde Company made any physical tests of those weld plates?

"A. No."

Mr. Oberlin: At this time may I interject that the statement was made, I think, in open court by counsel for the Plaintiff, that those weld plates are satisfactorily welded.

Mr. Wolfe: That is right.

Mr. Oberlin: That was admitted. Whether or not there have been other examinations made since this witness was examined, I do not know.

"Q. Well, using your Unionmelt flux in the prescribed manner but accidentally having an arc occur—I am using the word 'accidentally' as you have used it—does that effect the weld so far as you have observed?

"A. If the layer is small enough it will.

1879 "Q. But the mere fact that an arc does show itself when you employ Unionmelt flux does not mean an inferior weld necessarily, does it?

"A. I don't have any data on that. We have never run a test intentionally of that character, but if you have insufficient layer you can make the layer thin enough that you can see visually an inferior weld."

That, your Honor, will conclude our reading of this deposition.

Mr. Cahill: I would like to place a stipulation on the record at this time, your Honor—

Mr. Oberlin: Pardon me just a moment further, please. I offer in evidence at this time those portions of the deposition which has been read, and reserve the right to offer later any exhibits that were produced, in accordance with the request made, during the course of the taking of the deposition.

Mr. Cahill: I would like to place a stipulation on the record.

1880 I think counsel will stipulate with me that Dr. Nielson, a physician of New York City, may be deemed, without having been called in the proceeding, to have testified herein that the Witness James M. Keir

suffered from a severe bronchial infection, following an attack of bronchial pneumonia, in 1945, and has since been continuously under the doctor's care; that his condition became aggravated, and since October, 1946 he has been confined to his home; that he was ordered to Arizona by his doctor, and went as soon as he was able to travel in November, 1946, that after arriving in Arizona, his condition was diagnosed as tuberculosis, and he was ordered to bed for a complete rest cure, for a minimum of one year; that he is now confined to his bed in Tucson, Arizona; and that he cannot further be interrogated without serious injury to his health.

Mr. Oberlin: As stated by counsel, your Honor, we will accept the statement that the Witness is unavailable, because of the condition of his health.

1881 Mr. Byron: May it please the Court, I wish to read just a short excerpt from the deposition of Maynard Arthur Rotermund, the deposition taken on Friday, July 12, 1946, in San Francisco.

He was called as an adverse witness, and I read from page 217:

"Q. In these tests in the latter part of 1932, these tests or demonstrations using this composition of these compositions, as testified by Mr. Jones in the operation of welding was there anything done differently than in this commercial operation which had been previously going on there in the plant, except for the use of the different composition of the flux?

"A. Well, I'd say that in general they were similar. We had, of course, changed to alternating current. That was one difference.

"Q. You hadn't mentioned that in speaking of the change in the equipment. What kind of equipment had been used in the commercial operation?

"A. Direct current was used.

1882 "Q. Which was positive and which negative in the commercial operation?

"A. My recollection is that the work was made positive.

"Q. In these later tests, however, using this flux composition specially made up by yourself and associates, you used altogether alternating current?

"A. Well, not entirely. There would be times when we would for experimental purposes trade back to the direct current, but in the main I would say the tests were with

alternating current, particularly for the higher currents; when we were interested in the higher current welds we usually used alternating current.

"Q. Did you derive that current from the same or a different source than we used in the commercial operation of the Hetch Hetchy pipe?

"A. Well, naturally it was taken through the medium of a transformer, instead of a direct current generator.

"Q. In the matter of manipulation, however, 1883 the way the flux was laid on the work pieces and held there by these confining channels, the manner in which the welding head was traversed along the seam, and in all other respects, the operations were identical? Is that correct?

"A. Yes, that is true.

"Q. The only difference was in the composition of the flux that you were using?

"A. That is all I can recall at present, yes."

That is all of the Rotermund deposition. I offer that portion in evidence.

No objection?

Mr. Cahill: No.

1884 Mr. Byron: These are excerpts from the deposition of Lloyd Theodore Jones, one of the patentees, the deposition being taken on July 11, 1946, at San Francisco, and beginning on page 34.

Incidentally, he was called by the defendants as an adverse witness.

Beginning on page 34:

"Q. What was the voltage employed in this operation as practiced there in 1932 when you made your first contact with Western Pipe?

"A. I believe it was subject to the judgment of the individual operator, of whom there may have been a total of a dozen or more. If I remember correctly, it was 1885 in the neighborhood of 30 to 35 volts.

"Q. And what amperage?

"A. That, too, I believe, was subject to the control of the operator, and I believe they used somewhere in the vicinity of six hundred amperes.

"Q. With what diameter of wire or welding rod?

"A. Quarter inch.

"Q. What kind of current was it—A. C. or D. C.?

"A. D. C.

"Q. Which was the negative and which positive side—the welding rod or the work piece?

"A. I do not remember. I believe that, although they had tried both, they were using the rod positive; I believe that to be the case.

"Q. Do you recall at what rate the rod was fed to the work piece—that is, its longitudinal axial rate of movement?

"A. I believe that the sole requirement imposed
1886 upon the welding operator by the plant manager was that he produce a satisfactory weld, and that both welding speed, current and voltage were determined by the individual operator, but that general practice in their plant seemed to indicate a travel speed somewhere in the neighborhood of 10 or 12 inches per minute."

Now I will jump over to page 50, in the middle of the page:

"Q. Had you any knowledge at the time that these ingredients as given in Mr. Tallerday's sworn answer to interrogatory 59(g) in this previous litigation were mixed together and baked?

"A. Our information on their process was necessarily slightly sketchy. My remembrance is that a product consists of clay, lime, ferromanganese and whatever made up the final mixture was usually placed in a rotatable drum, rotated for mixing, and simultaneously heated to drive off any excess moisture.

"Q. What temperature was employed in this heating?

1887 "A. I have no knowledge of the temperature, but presume it would have been in the neighborhood of the boiling point of water.

"Q. Did Western Pipe have any name for this process of welding which you have described now at length in answer to my questions and which it had in use there at its South San Francisco plant in 1932?

"A. They spoke of the Robinoff process. Whether they designated their process as the Robinoff process, I do not remember, or whether their process was designated by any name I do not remember.

"Q. You associate that name Robinoff, however, with that process apparently?

"A. They told us of Robinoff, whom I did not know and whom I did not know of previous to their having mentioned him.

"Q. You had not known of a patent taken out in the name of Mr. Robinoff, I believe, and others, on a process of welding involving the use of a deep layer of flux at that time?

"A. We had not known of that until they told us 1888 that there was a patent either in process or issued—I don't remember which—and that related to a deep flux process which they were using."

Now, I will turn to page 54, starting in the middle of the page:

"Q. Now, coming back to the information which you derived from your contact with Western Pipe in 1932 with respect to welding under this deep layer of flux, Mr. Tallerday in a sworn answer to interrogatory 61—no, 62, I beg your pardon—62(e) propounded by the plaintiff, Linde Air Products Company, the plaintiff in the previous litigation, stated that the following information and data concerning flux materials and welding machines used at that time by Western Pipe was furnished either yourself or associates. I want to take these item by item as they appear in that answer—and I should say that this information thus given is further qualified as being "information and data concerning the so-called National Tube welding process or Robinoff, et al process' referred to in the previous answer.

1891 "The first item of the information which Mr. Tallerday states was furnished you and/or associates is as follows:

"'(1) Data not disclosed in Robinoff, et al patent No. 1,782,316, but desirable for successful operation of the Robinoff, et al process.'

"Were you furnished such data?

"A. I would not know to what he refers. They gave us or we saw in use the voltage, travel and current settings; they gave us the analysis of the flux used; they showed us analyses of the parent metal and weld metal and possibly of welding wire.

"I remember no further data that they gave or showed us.

"Q. Were those data furnished you in written form—record form?

"A. Data regarding current, voltage and travel were not given us in written form. We merely observed what

they were doing, and the welding operators told us
1892 the values which they used, and which we found was not consistent among their various welders."

I now turn to page 76, near the bottom of the page.

1893 "Q. Where did you make up this composition that you took from time to time to the Western Pipe's plant and there tested in a welding operation?

"A. We usually made up the composition at Kennedy's shop.

"Q. The one that you referred to in your testimony this morning?

"A. True.

"Q. What facilities did you have there for compounding it?

"A. His shop was on the same piece of land as a pottery, he being a tenant of the owner of the pottery—owner and operator of the pottery. Both possessed the facilities for weighing, and the potter possessed materials. Most materials to go into the flux we could obtain by walking twenty feet across to the pottery and weighing out the ingredients we wished to embody in the flux."

Now, I turn to page 80 in the middle of the page:

1894 "Q. In the preamble of the specification of that application you assert that you and your associates —that you jointly with your associates had invented new and useful improvements in the 'method of electric arc welding and a flux therefor.' Does that represent your conception of what you had done at that time, correctly entitled?

"A. Yes."

Those are all the excerpts I care to read, and I offer them in evidence.

Mr. Cahill: No objection.

The Court: They are admitted.

Mr. Oberlin: I might say that in connection with Mr. Jones' testimony there was offered a collection of patents taken out by him and his co-patentees in the patent in suit here, solely or jointly, and assigned to the plaintiff or one of the subsidiaries of Union Carbide and Carbon Corporation.

We do not care to offer that whole collection of patents, but only one, namely No. 2,152,194, dated March 28, 1939, in the name of L. T. Jones individually assigned to
1895 Union Carbide and Carbon Research Laboratories for electric arc welding.

I offer that in evidence as Defendant's Exhibit No. 137, your Honor.

Mr. Wolfe: No objection.

The Court: It may be admitted.

(Whereupon said document was marked DEFENDANT'S EXHIBIT No. 137 and admitted in evidence.)

Mr. Oberlin: Defendants next call Mr. Yeomans as a witness on their behalf.

LUCIEN I. YEOMANS, called as a witness on behalf of the Defendants and having been first duly sworn was examined and testified as follows:

Direct Examination by Mr. Oberlin.

Q. Please state your name.
A. Lucien I. Yeomans.
Q. Your age?
A. Sixty-eight.
Q. Your residence?
A. Chicago.
1896 Q. What is your occupation or profession?
A. Consulting engineer.
Q. Where do you have your office?
A. The Engineering Building, 205 West Wacker Drive.
Q. At Chicago?
A. Yes, sir.

Q. State briefly your general qualifications in the engineering field, indicating what branches of engineering you have had experience in and particularly what practical experience you have had?

A. I am a machinist by trade. After my apprenticeship I worked for several years as a journeyman machinist and toolmaker, foreman of tool rooms, and so forth, and then when I was about twenty-two years old I became superintendent of a factory in Antrim, New Hampshire, and I was also after that superintendent of one in Berry, Massachusetts, which I moved to Worcester.

I then came to Madison, Wisconsin, as superintendent of the Fuller and Johnson Manufacturing Company in 1903. In 1904 I came to Chicago as superintendent of the Link Belt Company, and three years afterwards I went to Armour and Company in charge of all their mechanical affairs at all points.

1897 Three years after that, I went to Sears, Roebuck and Company as general superintendant of factories, in which capacity I had thirty-six factories and twenty-two thousand people manufacturing a very wide variety of goods.

In 1913 I engaged in the consulting engineering business as an individual, and incorporated that business in 1922. I have operated it ever since.

Q. What particular experience, if any, have you had in the course of this contact with practical manufacturing operations, with electric welding, using the term in the general sense?

A. The first contacts I had with electric welding were with what would be called high voltage today, about 70 volt stuff, direct current, carbon arc, cast iron weld rods, used in connection with foundry work for filling holes in castings.

In fact, I recall distinctly that I stopped that practice in 1905 because I could not keep the foundrymen from filling the holes of work surfaces that were to be finished, and it would be impossible to machine them properly if that was done, so I can establish that date pretty clearly.

1898 The next contacts I had were afterward. I was making the Winslow safety high pressure boilers for steam automobiles, 800 pound pressure boilers, and was using oxyacetylene autogenous welds for welding the tubes into the headers, and a Quasi Arc representative came to see me and demonstrated to me the use of the Quasi Arc system with heavily coated rods. That was in 1919.

1899 Q. The rod there was a metal rod or electrode?

A. The rod was a rather small metal rod with a very small aluminum wire paralleling it, and the whole wound with blue asbestos yarn and coated with silica of soda.

Q. I was going to ask you if you know what the composition of blue asbestos is?

A. Yes. Blue asbestos is—the name the geologists give it is crocidolite. It is silicate of iron.

Sometimes in some of their rods they used white asbestos. White asbestos is chrysotile and amphibole. One ion of chrysotile, I think is straight magnesium silicate and the amphibole is a calcium magnesium silicate.

Q. These silicates that are known as asbestos are naturally-occurring silicates, are they?

A. Yes. They are long fibrous crystals.

Q. You say on this Quasi arc rod you noticed on this occasion the material was wound around the rod?

A. Yes. It was twisted into a kind of yarn, then wound helically around the rod and bound in place by dipping it in silicate of soda.

Q. What is the common name of silicate of soda 1900 that is used in domestic establishments and for other purposes?

A. Silicate of soda is the ordinary egg preserver that the farmers use.

Q. What is the common name for it?

A. Silicate of soda—water glass.

Q. It is also called water glass?

A. Yes.

Q. That is a soluble form of silicate of soda?

A. Yes. There are a great many varieties of it.

Q. Proceed with your statement of your experience with electric welding.

A. The next contacts I had with electric welding were about the fall of 1922 when I went to Milwaukee to the A. O. Smith Corporation for an entirely different purpose, to design a very large hydraulic press. I was there from November until February, and I was in the shop every day and simply observed what they were doing.

At that time they were welding a great many rear axle housings for automobiles. They had a department set up with special automatic machines which they had designed themselves, and at that time, 1922, were using alter- 1901 nating current, and they were still using that the next summer.

Q. What kind of an electrode were they using, if they were using an electrode in this operation?

A. They were using a paper coated electrode. Smith had—

Q. The rod was of what material itself?

A. The rod was a steel rod.

Q. Metal?

A. Yes. You see, an automobile housing just has to be tight enough to not leak oil, and it holds no pressure. The porosity of those welds was not important beyond a feature that they could hold oil.

Q. The welding there took the place of what other form of connection that had been previously used in that construction?

A. They used to bolt them together and rivet them together.

1902 Q. Proceed and briefly state what other contacts you have had with this art.

A. I went back there the next year, in November, 1923; I was brought back there and was made director of engineering for A. O. Smith Corporation.

In that capacity I had charge of their considerable engineering department and all their laboratories and was even their patent attorney. They were carrying on a development of electric welding which ran into millions of dollars and resulted in the tremendous equipment and facilities which they have today.

Q. Did they develop there, at the time of your connection, a method of manufacturing line pipe; that is, gas and oil pipe to be laid in the ground?

A. Yes.

Q. Using electric welding?

A. Yes. The designing of all of that equipment was completed before I left there in 1926, but they had not up to—well, they had made no large commercial shipments until the summer of 1926.

They had, however, developed in 1925 some very heavy work welding in the way of pressure vessels, oil

1903 refinery stills and so forth. Some of those shells ran three or three and a half inches in thickness.

Q. How was the welding done in the case of these pressure vessels, for example, at A. O. Smith, while you were there?

A. There was a lot of hand welding done. It was all coated weld rod. By that time Smith had developed their cellulose extruded weld rod.

Q. Did that succeed the paper covered weld rod you spoke of previously?

A. The paper-covered weld rod had, of course, a cellulosic coating, but later on they developed an extruded covering for the weld rod similar to those which your Honor has seen in Court as—what do you call them, Fleed-weld rod?

They were made of wood flour with mineral matter of different kinds and silicate of soda, and a thick paste or dough of that was made up and put through a sort of sausage machine which extruded it around the outside of the steel rod, and that is the way rods of that kind are made today.

But their first development between the heavy
1904 pressure vessels and the lighter automobile housings was a steel coupling development. At that time the only couplings for pipe lines or for weld pipe and pressure pipe were wrought iron couplings.

Wrought iron has a very low elastic limit and tensile strength, and yields very readily. We got started in that.

Mr. Stone who was superintendent of Jones & Laughlin came up there and brought us a coupling in which you could not even see that the threads were damaged, and yet something like 6,000 feet of pipe had dropped into a well by simply expanding it due to its weight, and then it was closed up without damaging the threads, so they wanted to get a steel coupling to—

Q. Was the electric welding process used to make steel couplings?

A. Yes. The electric welding process was used to make steel couplings up to 20-inch diameters.

Q. And proved satisfactory in that difficult field?

A. Oh, yes.

1905 Q. Now, proceeding with your experience with electric welding, have you had occasion to become acquainted with arc-welding? These were methods of arc-welding you described?

A. All arc-welding.

Q. Have you become acquainted with methods of arc-welding in which the flux, instead of being put on the electrode, was laid along the work piece to be welded?

A. Well, I have been familiar with reports on it and literature on the subject, and have discussed it with a great many people; but I had no actual contacts with it until less than a year ago.

Q. You had no occasion to use it?

A. No, sir.

Q. Or employ it in any welding operation?

A. No, sir. The first automatic welding I had to do was in 1927, and that was at Universal Products Company in Detroit, where they had an automatic welding machine, and I think that machine was built by a man named Goodspeed, an employee of the Cadillac Company. Anyway, it was a duplicate of some machines that Cadillac Company had.

Then later on, we bought, the next year—that would
1906 be December, 1927—we bought a Unamade in Cleve-
land. That operation was bare wire welding. It was satisfactory enough to the shop. The operation was to weld universal joints for automobiles, the drive shaft.

Q. Since you referred to automatic welding or automatic welding machines, what is the characteristic feature of their operation?

A. Well, they feed the wire from a reel, and that is supplied at the right speed, to the work, and it is controlled by the arc.

Q. The speed of this wire is controlled in that manner?

A. That is right. Today there are very accurate controls, but in those days they were very unreliable controls.

Q. What other automatic features are involved?

A. Well, to move the work satisfactorily. In that Detroit operation, that was a rotary machine, on rotated shafts. The welding was held at each end of the shaft, and the shafts rotated, with the universal joints in place, and they welded both ends at the same time.

If you were going to weld longitudinally, you would
1907 have to travel the pipe longitudinally, and not rotate it; but that wasn't done.

Q. Well, automatic welding or automatic welding machines have been in use for the time that would be indicated by this reference of yours?

A. Yes, and before that several years.

Q. And in those cases, bare wire drawn from the reel was used in the weld?

A. They were, and no flux, just the drawing, and a contamination of lime or whatever adhered to it when it is drawn.

Q. By the way, you speak of that contamination adhering to the bare wire. Is that also found in the bare rod?

A. Yes, that is right.

1908 Q. When we speak of that as contamination, is that a proper term, or has it some significance, in the form of the thin film of coating on the rod?

A. Well, it is usually not put on purposely, but sometimes it is.

The lime coating adheres to the wires as drawn in the

wire mill. They are generally coated by dipping in lime water when drying, to keep them from cutting the dies when you draw the water through.

It is also supplied with grease, which gives you a kind of mixture of lime and grease as a residue on the surface of the wire.

I have seen lime and iron rust and whiting, as a coating on the rod.

Q. What is the purpose of either placing or keeping the thin coating of material on the wire or rod?

A. It is easier to strike an arc.

Q. Does it also assist in maintaining the arc once struck?

A. Yes. A perfectly clean rod doesn't strike very easily.

Q. You spoke of having observed, a year or so past, an automatic welding operation in which there
1909 was flux used, laid on the work piece or the work to be welded.

A. Yes.

Q. What process was that you saw?

A. Actually I saw it first at the Graver plant, in May, when I saw that demonstration over there, and that was Lincoln.

Q. That was May of last year?

A. Yes. That was a Lincoln machine, Lincoln wire and Lincoln flux.

Q. And you were present throughout that demonstration?

A. Yes, sir, I was.

Q. You have seen the pictures, I think two reels of motion pictures, and also a number of still photographs here in evidence as Exhibits, offered by the Plaintiff?

A. Yes, sir.

Q. Those pictures relating to that demonstration, taken at the time of that demonstration?

A. Yes.

Q. And do they correctly portray, as they show views of that operation that was carried out or succession of
1910 operations, what you actually saw yourself?

A. I thought they very well did so.

Q. Have you in the interval seen this process of weld-

ing under a deep layer of flux elsewhere than at that demonstration at the Graver plant?

A. Yes, sir, I have; I have seen some done in the Lincoln laboratory, and of course, I have seen the demonstrations that were made before this Court.

Q. Including the one that was made yesterday.

A. Yes, sir.

Q. When we returned to the Graver plant—

A. Yes.

Q. —and conducted the several tests there.

A. Yes, sir.

Q. Have you had occasion, between the time of the demonstrations which were carried on last May, May 21st, 1946, and the visit to the plant of the Graver Company yesterday, to visit that plant and observe welding operations carried on there, using the Lincolnweld process?

A. Yes.

Q. When did you make such a visit?

A. November 27th.

1911 Q. Of what year?

A. 1946.

Q. How much time did you spend there?

A. Well, I was there from 10:50—well, that is, the first welding that I saw was at 10:50, but I was there about ten o'clock in the morning, and I stayed there until they closed down at three-thirty in the afternoon.

Q. And what did you do while you were there, during that time?

A. Why, I strolled around the shop, and observed any welding operations that were going on there.

Q. And were such going on in which the Lincolnweld automatic equipment and flux laid on the work pieces, figured?

A. Yes, sir, there were, in four locations.

Q. Supposing you describe actually what you saw in each of these operations at that time.

A. Well—

Q. (Continuing) That is, not going into too much detail, Mr. Yeomans. I am merely directing your attention to, or asking you to particularly comment on, what you observed in the behavior of the flux, the depth of the flux

layer, the behavior of the welding operations, and the
1912 phenomena generally of the welding which was carried on.

A. I have my original notes here. At 10:50 that morning I saw a Lincoln tractor welder in operation.

My notes say that the tube was 1-1/4 inches above the work; that a 3/16ths rod was used, granular flux; the current was 40 volts, 650 amperes; the speed was 20 inches per minute.

Now I said that it was a 3/16ths inch wire. I had that noted, but it was really 7/32nds because I corrected it when I found that out.

The plates were half an inch, that were being welded. The name of the operator was Charles Rose; the foreman in the department was Ben Smith. They were using No. 660 flux.

This was in what they called their welding building, which is a building where they make bases for Diesel engines, and stuff of that sort, flat plate work mostly.

My notation on that is that there were occasional sparks, and that was all that was visible during the operation.

Q. How long did you observe that operation?

1913 A. Well, while they welded one seam, I suppose, about four feet long.

Q. Did you give any instructions to the operator there at this station, or at any other station where you made similar observations?

A. No, sir, I gave no one any instructions.

Q. You may proceed.

A. The next notation that I have was over in the Plate Shop, in the L. I believe that they call it their O Shop.

As a matter of fact, it was the exact location where that wooden platform was erected yesterday.

Q. Do you mean, at the demonstrations out at the plant yesterday?

A. Yes, sir, in the L of that shop. It used to be called, years ago, the coal shop.

They were using a squirt welder there on 3/16ths inch plate.

Q. Now, what kind of a machine is that?

A. I think that the proper name of it—the men all call

them squirt welders, but I believe that the proper name is a semi-automatic welder.

It has a head that has a remarkable performance.

1914 It is held in the hands of the operator—

Q. Well, is there a bare wire used in that operation?

A. Yes.

Q. And is there also a layer of flux laid along the work piece?

A. Yes.

Q. Through which the wire projects—or into which the wire projects, during the welding operation?

A. It has a cone on it, which holds about two and a half pounds, I believe, of the 660 flux, and it feeds out of the bottom of it, just about to the wire welding position.

It does not use anywhere near as much flux as we are accustomed to seeing on the larger machines.

Q. All right. You may proceed with your observations at that station, or operation, particularly with regard to the performance of the flux and the welding operation thereunder.

A. They were welding a domed head; it was the lap weld of a domed head, inside of the shell.

1915 This job was 5 feet 5 inches in diameter, which would be 204 inches in circumference, and it was being welded by Andrew Vandra, who was a sort of a subforeman there.

The plate was 3/16ths of an inch, and he was moving at a speed of about 26½ inches per minute.

Q. That is, with the weld rod being moved along the groove?

A. That was the rotation of the shell.

Q. All right.

A. He was on top, and the shell was rotating underneath him.

Q. You may continue with your observation.

A. That was a 64ths inch wire. That is only about ninety-three thousandths of an inch in diameter; and it was very fast.

They were using 2 0 amperes, and the voltage setting was 8½.

Now, that is a blind setting, as far as I am concerned. I asked what it was, and was told that it was about 30 volts; but I have no way of knowing that.

1916 Q. Just state what you saw there, now, please, Mr. Yeomans.

1917 There were only occasional sparks, and I noted that the thickness of the flux was unusually thin; it was perhaps running from one half inch to five-eighths of an inch thick.

At any rate, one of those cones was used; they welded 100 inches, with one coneful of flux.

By Mr. Oberlin:

Q. Now, this cone was more like a funnel, if I correctly get the picture which you have given, because the material fed from the lower end of it, the small end of it?

A. Yes.

Q. Is that it?

A. Yes, sir, that is correct. It was about—the cone was about one foot long, and about three and a half inches in diameter at the top, and about one and one half inches in diameter at the bottom; and I would guess that it held about two pounds of flux.

Q. Now you spoke of sparks as having been observed, both in this operation and the one which you previously described.

1918 What do you mean by sparks?

A. Why, arc flashes.

Q. How did you know that they were arc flashes?

A. Well, I have been looking at them for twenty years, and they looked just like all of the arc flashes that I have ever seen.

Q. Now, you said that you saw several other operations. Will you go ahead, briefly, and tell the Court what you observed there?

A. I saw another job, which was a Seed tank, order No. 28641, which was done in their plate shop L.

That was done on the same machine that was demonstrated to the Court yesterday.

This was a case—

Q. You are referring now to the automatic machine, are you?

A. The large automatic machine, yes, sir.

Q. Used in demonstrations 3 and 4?

A. Yes, sir.

Q. Continue.

A. This was a case of welding a five-eighths inch domed head, with a quarter-inch shell.

They welded both the girth and longitudinal seams in this operation.

1919 Q. While you were watching the operation?

A. I watched them all, yes, sir. This tank was four feet in diameter, and five feet six inches long.

They were using 17.6 inches per minute on the girth weld, with a five-thirty seconds wire.

The operator was Edward Fischer.

I looked up the order number on that, and it was a clarifier tank.

Q. What did you observe at to the welding operation?

A. I have a notation here showing that the flux was an inch and a half above the work, and they started with 500 amperes.

1920 Q. Proceed, please.

A. They started with 500 amperes, and 33 or 34 volts, and they increased that to 520 to 540 amperes, at 34 volts, and there was considerable arcing visible, and occasionally flames and flashes. Bead was seven-eighths of an inch wide.

I have got a notation here, "More arc flashes than in the pictures."

Q. You are referring now to the pictures which have been introduced as exhibits by the plaintiff, are you?

A. Yes, sir; that is, the pictures that I saw taken there in May.

Q. And you had in mind, having seen those pictures in the interval, what they looked like?

1921 A. Yes, sir.

Q. Will you now proceed with your next operation.

A. Yes, sir.

Q. I think that you said there was one more operation witnessed by you.

A. Yes, sir. The next job was welded by Michael Yatzo. He is the welder who operated yesterday afternoon over there.

That was a three-eighths of an inch shell, a half-inch head; sixteen inches per minute; a 7/32 inch wire; 550 amperes.

I have a notation here of 38, 36 and 35 volts. The chute was one and three-quarters inches above the plate.

This was a peculiar fitted-up job, and I have got the note "Burned through; hand repair." I will explain in just a moment what that was.

One side was beveled—it had been fitted up evidently to make a beveled butt weld, but one side was straight, and the other side was beveled, so that in order to correct that mistake, why, it had to be welded rather carefully.

So at first he started out with 550 amperes, 38 volts,
1922 and then 36 volts, and then 35 volts, and he burned through, and it had to be hand-repaired. Now, what he had to do was this: He had very little metal there to support that. He had burned it through on account of the overamperage that he was using, so he had to stop and take a hand rod and weld up the hole.

Then he cut his amperage down to 475, and 38 volts. No sparks or arc were visible at first, and then I state "occasional arc."

He went around once that way, and the flux was three-quarters of an inch thick after the rod had passed, and was an inch and a half thick before, and measured three-and three quarters inches wide.

Then after he had gone around the first time, and had it sealed up, he raised the amperage to 575, for the second pass.

This job was a 5,000 gallon fermenter tank, order 28640, 9 feet in diameter and 10 feet high.

Q. What did you observe with regard to sparks, as you call them, or as flashes in this second pass, if any?

A. Well, they were always visible, but not as
1923 numerous on this particular job as they were in the pictures.

The deposition of metal here, on account of the cutting down of the amperage, on account of the shape of the fit-up, evidently with the same flux that he was usually using, did not show so much flashing—that is, there was less flashing there than I had been accustomed to seeing on the others.

1942 Q. You spoke of using a second pass in this last operation.

A. Yes.

Q. How deep—or rather how thick were the plates that were being welded there, in this rather oddly set-up fashion?

A. The plate was three-eighths of an inch thick, and

the head was one-half inch thick. This was a domed head. He used the same speed, 16 inches per minute, and the same wire, a 7/32 of an inch wire.

When he started, he had 550 amperes, and that was obviously the reason why he burned through.

1925 Q. I was not curious about that, Mr. Yeomans. I was interested in the fact that the operator made a second pass.

A. Yes.

Q. That is, he went around two times.

A. Yes.

Q. With the weld rod being melted into the seam.

A. Yes, that is right.

Q. Was that an unusual procedure in the use of the Lincolnweld equipment and process, as you have observed them?

A. I have not had enough experience with the granular form of flux, to know what the practice is.

That would be a very unusual practice, however, in the old days of the coated rod. After the first time around, they would chip the scale off, and brush it off.

Q. No; I mean, as to the number of passes, to make a weld of that depth.

A. Oh, yes. That should have been done in one, if it had been fitted up properly.

1928 Mr. Oberlin: We will only take a minute for that. Mark this for identification with the next number.

(Whereupon the said document was marked Defendant's Exhibit 138 for identification.)

Mr. Oberlin: I have had marked for identification, as Defendant's Exhibit 138, a compilation of the specifications, as filed in each of the three applications, of which certified copies have been offered in evidence by plaintiff, being the three applications out of which ultimately the patent in suit emanated.

The specifications are arranged with corresponding subject-matter, in transverse style of arrangement, to facilitate comparison by this witness or others.

The Court: (To the witness.) You may step down, if you care to.

Mr. Oberlin: Mark this for identification as Defendants' Exhibit 139.

1929 (Whereupon the said document was marked Defendants' Exhibit 139 for identification.)

Mr. Oberlin: I have similarly marked for identification, as Defendants' Exhibit 139, a chart carrying certain figures from the drawing of the J. C. Lincoln patent No. 1,589,017, with quotations from the text or specifications of the patent.

This will be the next number, 140.

(Whereupon the said document was marked Defendants' Exhibit 140 for identification.)

Mr. Oberlin: This is a similar chart in connection with the Robinoff patent No. 1,782,316.

Both this Lincoln patent and the Robinoff patent have heretofore been placed in evidence.

Finally, a similar chart of the Jones patent No. 2,152,194, being the patent just offered at the conclusion of the reading of excerpts from Col. Jones' deposition, as 141.

(Whereupon the said document was marked Defendants' Exhibit 141 for identification.)

1932 By Mr. Oberlin:

Q. Mr. Yeomans, do you have any familiarity with patents generally?

A. I have.

Q. In what manner have you thus become acquainted with patents?

A. Why, I have taken a great many myself; I have supervised the patent matters of several corporations; and I have also testified in some patent suits.

Q. Referring now to the Jones et al patent in suit, have you had occasion to study that?

A. I have.

Q. To what kind of improvement or improvements does that patent purport to relate?

A. The patent purports to cover a novel method of electric welding, and a conductive composition to be used in connection with that method of electric welding.

Q. And have you also considered the file wrapper and contents of the patent in suit?

A. I have.

1933 Q. A certified copy of the wrapper is here in evidence as one of the Plaintiff's exhibits.

A. Yes.

Q. You have studied that, have you?

A. I have.

Q. In duplicate form?

A. Yes, sir.

Q. Now, the file wrapper in question, and also the patent in suit,—I am referring to the top of Column 2, page 4, of the patent—states that the application on which the patent was granted, is a continuation in part of prior applications, Serial No. 657,836, filed February 21, 1933, and Serial No. 705,892, filed January 9, 1934.

Have you also considered the file wrapper and contents of those applications?

A. I have.

1935 Mr. Oberlin: Well, I make that statement—and it will not be contradicted on the record—on those two files, each was successively abandoned, and the dates of abandonment will be called to the attention of the Court.

By Mr. Oberlin:

Q. You have, however, had an opportunity to review the file wrappers in the two prior applications?

A. I have.

Q. What was the subject-matter in the first application?

1936 A. It was an application for a process of electric arc-welding, a flux that was used in connection therewith, and a method of making the flux.

By Mr. Oberlin:

Q. What was the subject-matter of the second application, as indicated from your review of the file wrapper?

A. A method of electric welding, and a composition of matter which is used in connection therewith.

By Mr. Oberlin:

Q. Was the method of arc-welding, to which the second application was addressed,—was the method of elec-

1937 tric welding, I believe you said, to which the second application was addressed, the same or different than that to which the first application was addressed?

Mr. Cahill: That I do object to. This is an attempt to argue the legal effect of difference between the exhibits in evidence. I submit this witness is not competent to testify to that.

The Court: Well, I think that I shall overrule the objection.

1950 Mr. Cahill: So that I may not be compelled to keep interrupting the examination of the witness as it goes along, your Honor, may the record show that I have a continuing objection to the entire line of examination?

The Court: Well, if it relates to the same matter, yes.

Mr. Cahill: Yes.

The Court: If the same line of questioning is pursued, you may.

Mr. Cahill: Yes, because I do not want to have to keep interrupting.

Mr. Oberlin: Now, will you read the question again for the benefit of the witness, please, Mr. Reporter.

(The question was again read.)

A. It was entirely different.

1951 By Mr. Oberlin:

Q. Now, Mr. Yeomans, will you describe just briefly your understanding of the method of electric welding which is set forth or taught in the second application?

A. The alleged invention is directed to a method of electric welding, in which an electrode, supplying the current to another electrode, receiving it, transmits that through a conductive melt, which is a composition of matter as described in the patent; and the heat for melting the work pieces to be welded, and for melting the electrode which is supplying additional metal, and coalescing or binding those molten elements, is supplied entirely through the conductive material.

Q. In the first part of your statement, Mr. Yeomans, you referred to one electrode, and a second electrode, and in the latter part of your answer, you spoke of work pieces.

A. Well, the work pieces are the electrodes—or rather, one electrode, and the weld rod is the other electrode.

Q. That is a general electrical definition of the parts in question, is it?

1952 A. In this art, yes, sir.

Q. In other words, they may both be spoken of in electrical terms, as electrodes, may they?

A. Yes, sir.

Q. Although actually, in this welding operation, as we

are concerned with it here, the one electrode is the metal weld rod, as we have also called it.

A. Yes.

Q. And the other consists of the work pieces, or the adjacent edges which are to be interfused.

A. Yes.

Q. Actually, where alternating current is used as the source of energy—

A. They are both electrodes, in that case, but the current reverses in its direction.

Q. Where the direction of the flow of the current is uniformly in one direction, what do we sometimes call the electrode from which the current passes, and the one to which it passes?

A. The cathode is the one from which it passes, and the anode is the one to which it passes.

Q. And that distinction is sometimes indicated by a plus or a minus sign; is that correct?

A. Yes, sir, that is correct. The plus sign is the one
1953 to which it passes, and the minus sign is the one from which it passes, in such cases.

Q. Now, Mr. Yeomans, we were discussing—or rather, I asked you a question as to the disclosure in the second application. That application is not the one upon which the patent in suit actually issued. The third application is the one upon which the patent was granted.

With which of the previous applications does that correspond in the matter of the teaching of how the welding is to be done, the first or the second?

A. The second, of which it is an amplification.

Q. You have seen this exhibit which was marked for identification yesterday as Defendants' Exhibit No. 138, I believe?

A. Yes.

Q. Will you please just describe briefly of what that consists?

A. It consists of the specifications of the three several applications referred to, taken apart and pasted together in progressive relation, so that the sheets at the left of each combined sheet are matter of the specification of the first

application; those in the center are matter taken
1954 from the second application specification; and those on the right are extracts—or rather, I should say they are the specifications of the third application.

They are so pasted together and arranged that relatively the same subject matter can be read from left to right and across the page.

Where there are skips in the sheets, the skips show that there is nothing similar in the applications which contains them.

Q. If you will turn, for example, to the three sheets marked sheet 9—

A. Yes, sir.

Q. —being, I believe, the next to the last in the exhibit in question.

A. Yes, sir.

Q. Sheet 9 under the caption "Jones et al., first abandoned application" is completely blank; is that correct?

A. Yes, sir.

Q. And what does that mean as to the matters that appear on the corresponding sheets under the captions "Second application" and "Third applications of pat-
1955 ent in suit"?

A. That means that that matter did not appear in the first application.

Q. That was added to the second and third applications, was it?

A. Yes.

Q. With such modification as may appear upon comparison?

A. Right.

Mr. Oberlin: I offer Defendants' Exhibit No. 138 for identification, in evidence at this time.

Mr. Cahill: No objection, your Honor, other than the one upon which the Court has ruled, as to the entire line.

The Court: The objection will be overruled, and the exhibit admitted.

Mr. Becker: What is the number of the exhibit again, please?

Mr. Oberlin: 138.

(Whereupon said DEFENDANTS' EXHIBIT NO. 138 was admitted in evidence.)

1956 By Mr. Oberlin:

Q. Referring again to the patent in suit, Mr. Yeomans, does it contain any drawing such as is frequently found in letters patent, which illustrates the process or the apparatus required in its use?

A. It does not.

Q. I call your attention to Defendants' Exhibit No. 141, being a copy of a somewhat later issued patent to one of the patentees of the patent in suit, L. T. Jones, the number of the patent being 2,152,194, and ask you whether it affords such illustration of apparatus or process as would be used in carrying out the process of the patent in suit.

A. Yes, it does.

Q. What figures in particular of the drawing in this patent are thus illustrative of the process of the patent in suit?

A. Figures 1 and 2, with some additional matter on Figure 2, that pertains strictly to the application number 2,152,194.

1957 Q. That is the later patent?

A. Yes, sir.

Q. And is there a description afforded by this second patent, a statement of the teachings of the first patent, referring to these figures which you have just identified in the drawing?

A. Yes. In line 45, column 2, page 1, to line 5, column 1, page 2.

Q. Those matters, descriptive statements, are found in this chart, Defendants' Exhibit 141 for identification?

A. Yes, the first paragraph of that chart.

Q. And does the description there found accord with your understanding of the description of the process in the patent in suit?

A. It does.

1958 Mr. Oberlin: We are content to let the chart stand as an ample basis for the Court's understanding. I was simply desirous of facilitating that understanding by having certain excerpts read.

I offer in evidence the chart previously marked for identification as Defendants' Exhibit 141.

Mr. Cahill: No objection, except as to the entire 1959 line.

The Court: I will overrule the objection, but I would like to make inquiry of counsel, was the Jones patent issued subsequent to the patent in suit?

Mr. Oberlin: The inventor himself in this later patent —to which this chart relates, and the patent 2,152,194 which it exemplifies—the description given there is illustrative of the original patent in suit. It is the inventor's own interpretation of the teachings of the patent. That is the object of the exhibit, and our reference to both it and the patent.

The Court: Objection overruled.

(And thereupon DEFENDANTS' EXHIBIT 141 was admitted in evidence.)

Mr. Oberlin: Will you mark these the next numbers?

(Whereupon the said documents were marked Defendants' Exhibits 142, 143, 144, 145 and 146, for identification.)

Mr. Oberlin: I now offer in evidence several collections of patents heretofore cited in the defendants' answer or in notice given the plaintiff.

1960 As Defendants' Exhibit No. 142—I will give you the numbers, I haven't extra copies in this separate form—two patents illustrative of the old forge welding compound, patent number 277,393, to Whitcomb, and 1,283,909 to Roberts.

I offer in evidence as Defendants' Exhibit 143 two patents relating to electric furnace fluxes, namely, Nos. 721,703 to Heroult, and 1,532,052 to Greene.

As Defendants' Exhibit 144 I offer in evidence a collection of four patents relating to Quasi-Arc type fluxes, namely patents Nos. 1,041,525 to Strohmenger, 1,241,899 to Armstrong, 1,277,639 to Piscatore, and 1,441,685 to Jones.

As Defendants' Exhibit 145 I offer in evidence four patents directed to prefused welding compositions comprising Nos. 1,467,825 to Armor, 1,741,031 to Miller, 1,748,785 to Miller, et al, and 1,754,566 to Miller.

I offer in evidence as Defendants' Exhibit 146 a collection of patents cited against the Jones, et al appli-
1961 cations during the course of their prosecution in the Patent Office, but not included in Defendants' answers or in these other answers.

A list of these was furnished in connection with the notice given the plaintiff following the pretrial conference, or at the time, and I think it is incorporated in the order, your Honor.

These will not be referred to. They are merely for the information of the Court, and if the Court desires to see what patents were cited and how incomplete the Patent Office search of the prior art was.

The Court: Is there any objection?

Mr. Cahill: No, except to counsel's argument. I think we might save that until the end of the case. I have no objection to the exhibits.

Mr. Oberlin: It was a purely explanatory statement.

Mr. Cahill: I understood that. I think both sides resist the temptation.

1962 Mr. Oberlin: I think I have done fairly well, sir.

The Court: Objection overruled. The exhibits will be admitted.

Mr. Cahill: I said there was none, except to his remarks.

The Court: The exhibits are admitted.

(Whereupon the said documents marked DEFENDANTS' EXHIBITS 142 to 146, both inclusive, were admitted in evidence.)

By Mr. Oberlin:

Q. Now, Mr. Yeomans, I call your attention to the two patents comprised in Defendants' Exhibit 142 (handing documents to witness).

A. Yes.

Q. First of all, the one to Whitcomb, No. 277,393.

A. Yes.

Q. Just state very briefly the nature of the disclosure of this patent.

A. Whitcomb relates to a new flux adapted to clean and promote the uniting of metals by welding, brazing or soldering, and he says:

"Take fluorspar, one hundred parts, by weight, finely pulverized, and four pounds of soda-alum freed from
1963 its water of crystallization, finely pulverized, and mix the two powders thoroughly."

Q. What is fluorspar?

A. It is silicate—

Q. Fluorspar.

A. Fluorine and silica. Calcium fluoride, in other words. They are the same thing.

Q. You used the word "silica" which puzzles me.

A. I mean, it is calcium—it usually contains silica, but it is a calcium fluoride.

Q. Is fluorite another name for that compound?

A. Yes, sir.

Q. That is a naturally-occurring mineral form of calcium fluoride, is that right?

A. That is right.

Q. It does contain, usually, as an impurity, silica?

A. That is right.

Q. Does that illustrate the use of flux, then, of calcium fluoride as an ingredient?

A. It does.

Q. The second patent in this collection to Roberts, No. 1,283,909—what does it show?

A. It relates to chemical compounds and mixtures for use in promoting the joining of metallic parts in
1964 welding processes.

Q. Does it refer to any specific type of welding processes?

A. No.

Q. It is a general flux for general welding use?

A. For uniting metals in welding processes.

Q. What about the composition disclosed?

A. Again there is fluoride in this. In lines 90 to 95 he says:

"* * * comprehends in addition to providing the usual fluxing agents, the provision of a natural mineral compound of aluminum such as cryolite, fluorite, or other combinations of aluminum and fluorin."

Q. The "fluorite" there mentioned is calcium fluoride?

A. Calcium fluoride.

Q. That is, it teaches that you can use—is this correct—either aluminum fluoride or calcium fluoride?

A. That is right.

Q. Are they, to your knowledge, familiar fluxing ingredients?

1965 A. They are used in practically all slags where fluidity is to be promoted.

By Mr. Oberlin:

Q. What about the other ingredients in this Roberts flux to which the fluorite compound is thus added? Does it include any compound which you would identify as a metallic silicate?

A. Yes.

Q. Which one?

A. Powdered glass is in it, and then there is a large quantity of sand in it and borax, and when molten this would be metallic silicate, and the glass already is a silicate.

Q. Glass is what kind of a silicate?

A. It is a silicate depending upon which metal was used, what the silicate is, but it is a silicate made from metallic oxides and an acid, a silicic acid.

Q. That is, silica?

A. Yes.

Q. They are fused together in making glass?

A. Yes.

1966 Q. In this composition, then, of the Roberts patent, you have a metallic silicate, is that right?

A. Yes.

Q. You previously said that you found a fluoride, and specifically calcium fluoride, named as an ingredient?

A. That is right.

Q. Will you take the second group of these patents, Exhibits No. 143, which I have identified as electric furnace fluxes, and describe briefly the composition of fluxes set forth in these patents. First take Héroult, No. 721,703.

A. On page 2 of the Heroult patent, line 22, is that description:

"The slag which forms the resisting medium in which the heat is produced may be various compositions. For example, when the furnace is used for the production of metals the slag is most imperfectly-reduced mineral matter, or if the furnace be used to obtain stability of composition of fine steel with other elements—such as chromium, nickel, tungsten, etc.—the slag is composed chiefly of

1967 reagents designed to act on the bath of metal—such as lime, dolomite, or oxide of iron liquefied by the addition of silica—or it may be substantially neutral, such as a fusable silicate which has no chemical action on the bath."

Q. Now then, I think it unnecessary to ask you to describe the electric furnace. Is a typical electric furnace shown in this patent, more particularly in the drawing?

A. One type of electric furnace is shown, yes, sir. It is described as two separate arcs in series according to this invention, employed to play through the insulating layer

of the slag between the metal or the fused conducting material on the one hand and the two electrodes on the other hand.

Q. Referring to the second patent in this group, to Greene, 1,532,052, will you similarly point out any description you find therein of a flux suitable for use in an apparatus or process of this type?

A. This is a steel furnace, and he says, at the top of the second column, page 1:

1968 "My invention, accordingly, involves treating iron or steel in a basic electric furnace by applying thereto a slag comprising lime and silica approximately in such proportions as to form a neutral mixture, that is, a mixture that is neither strongly acid nor strongly basic, and maintaining the metal and slag molten under reducing conditions. The actual percentage of silica in that slag will vary considerably for different materials and circumstances, but will generally be between 25 and 35 per cent of the total weight of the slag."

Again, on page 2, line 37:

"An important feature of the present invention resides in the modification of the heretofore customary highly basic slag by the addition of a relatively high percentage of silica, thereby giving the slag a considerably lower melting point, rendering it more fluid and facilitating its refining action."

1969 At line 55:

"By making the slag fluid by means of silica, in accordance with the present invention, it is possible to pour the slag directly from the furnace instead of having to rake it out as may be necessary with the heretofore customary highly basic slags, or instead of using considerable quantities of fluorspar at an unnecessary expense."

Q. The silica is proposed here as a substitute, do I understand correctly, of fluorspar in these slags or flux?

A. That is his statement, yes.

Q. And the fluorspar again is what?

A. Calcium fluoride. He does not limit it. In the next sentence he says:

"While the process of my invention is not dependent upon the use of any particular type of electric furnace, I have * * *"

He describes the electrodes at line 90, Column 2, page 2, as follows:

"Electrodes extend through the walls of the furnace and dip into the slag. By tilting the furnace the amount of electrode in the slag may be regulated or it can be
1970 kept out of the slag. When the electrodes dip in the slag a current of low voltage and high amperage is preferably employed, and the current may be regulated by varying the voltage. Either direct or alternating current may be employed."

Then on page 3, line 32:

"To maintain the slag fluid at such a low temperature, it is necessary that it contain more than 15 per cent of silica."

I might say that the temperature he mentions is 1325 C., which appears in line 27 just above.

Then at line 38 he says:

"The slag may contain as much as 30 per cent of silica and at a temperature of approximately 1400 degrees Centigrade."

That is all that relates to silica.

Mr. Oberlin: I think that is sufficient for our present purposes, Mr. Yeomans, as far as that type of slag is concerned.

By Mr. Oberlin:

Q. Now, the next group of patents, Defendants' Exhibit 144, comprises patents which I have designated
1971 in the offer of the exhibit as Quasi-Arc type fluxes. I believe you have stated in your previous testimony yesterday that you are acquainted, and have been acquainted in the past with what is known as the Quasi-Arc weld rod?

A. I have.

Q. What is this document which I now hand you, which I ask to have marked Defendant's Exhibit No. 147 for identification.

(Whereupon said document was marked Defendant's Exhibit No. 147 for identification.)

1972 A. That is an instruction sheet for operators, for use of the Quasi-Arc electrodes.

Q. And how long has this circular been in your possession, Mr. Yeomans?

A. Well, positively, since 1932, and probably since 1919.

Mr. Oberlin: I have no photostat of this, gentlemen.

By Mr. Oberlin:

Q. Does it describe the Quasi-Arc as you have testified yesterday you had become personally acquainted with it, through demonstration and otherwise?

1975 A. It does.

Q. In particular, does the circular now afford any illustration of the manner in which the Quasi-Arc weld rod was intended to be used?

1976 The Witness: Yes.

Mr. Oberlin: I now offer the exhibit in question—or rather, the circular, in evidence.

1977 Mr. Cahill: And it is objected to on the grounds previously specified.

1979 The Court: In line with Mr. Oberlin's statement that it is not intended to raise anticipation as far as the patent in suit is concerned, with that statement made, are you prejudiced?

Mr. Cahill: Oh, I think so. I think once you get these in, the limitations on which they are admitted sort of get lost in the shuffle, and you get yourself confronted 1980 at this late date with something new.

If counsel had said that in the preparation they overlooked this and for that reason had to bring it in at the last minute, there might be some reason for discretion; but we find ourselves at the eve of this case, when the Defendants have about completed their case, confronted with something we know nothing about. They gave us no prior notice of this circular; we have not seen it, and I don't think we should be confronted with it at this time, if it is not anticipatory. It is not material.

The Court: That is the only question in my mind, on what basis it is offered.

Mr. Oberlin: I think I might be able to clear that up with one question.

By Mr. Oberlin:

Q. Does the statement to which you have called attention in this circular, Mr. Yeomans, correctly illustrate, in your opinion, the manner in which the Quasi-Arc was used, as you have heretofore testified?

A. Yes, sir.

1981 Q. You are referring to the illustration under "Summary of Essential Points," on page 11 of this Exhibit?

A. Yes.

Mr. Oberlin: That is all I have to ask this witness.

The Court: What is the materiality?

Mr. Oberlin: It is illustrative, it affords an illustration or a drawing, which the witness might be called upon to make of how the Quasi Arc might be used. That is the only use and only purpose of the question. I think it is entirely proper.

I could have him make a drawing, and many witnesses have.

Mr. Cahill: This witness has been in the case six months, he said, and has had this in his possession ten years. Lacking a showing that there was some element of it he overlooked, and apparently there wasn't,—

The Court: He says he is not advancing it on the ground of anticipation. I fail to see yet where there is a surprise element.

Mr. Cahill: If he says it is not, I object on the
1982 ground that it is immaterial. I don't think anything should be so offered at this time, and without prior notice. If it isn't material it should be kept out.

The Court: That is the question in my mind.

Mr. Oberlin: It affords a convenient way of having the witness illustrate what he has testified to.

Mr. Cahill: I object on the ground it is immaterial, and that is the only ground on which it could be admissible, I admit.

The Court: Well, in the light of Defense counsel's statement as to the purpose of it, I think I will sustain the objection.

1986 By Mr. Oberlin:

Q. Will you now refer to the four patents comprised in Defendant's Exhibit No. 144, Mr. Yeomans. What do they disclose, respectively; and I first call attention to Strohmenger's Patent No. 1,041,525.

1987 A. This patent covers an electrode coating, described starting at line 54 on page 1, as follows:

"The insulating material which I prefer to use is asbestos spun into the form of a yarn and smeared with a suitable composition such as sodium silicate, aluminum silicate and the like to vary the fusing temperature of the yarn:

and the asbestos which I find to answer best is blue asbestos which is a ferrous silicate and acts rather as a reducing than as an oxidizing agent so that it must effectually prevent oxidation of the deposited metal.

"The thickness of the material *e* will depend upon the size of the electrode and the strength of the current, the greater the current the thicker being the material."

And then continuing at line 71, on the same page, he describes the operation. He says:

"The end of the electrode is bared and an arc is
1988 struck by a piece of carbon or other convenient means; the arc fuses the covering and melting the electrode moves slowly along the seam.

"The fused covering acts as a flux and prevents the molten metal coming in contact with the air, thus preventing porosity."

By Mr. Oberlin:

Q. The second patent in this collection is No. 1,241,899, to Armstrong.

Will you please briefly describe what is there set forth in the way of a flux?

A. This invention relates to welding electrodes and their coatings, and he describes a nonmetallic coating which is adapted to act as a slag when fused.

Starting at line 48, on page 1, he says:

"* * * the inner slag is preferably made equal to or of a slightly higher melting point than the metal core. But the metal will work with an inner slag of a lower fusing point than that of the metal core.

1989 "For horizontal work, I preferably make the inner coating of a lower fusing point than that of the metal core, but it is quite possible to obtain excellent results with the inner slag of a higher melting or fusing point than the metal core.

"The inner coating may consist of any suitable material or combination of materials such as blue asbestos, which may be in the form of yarn and smeared with a suitable composition, such as sodium silicate, aluminum silicate, or any other suitable, well known composition, that will either raise or lower the fusing point of the asbestos as desired, according to the circumstances."

Then continuing at line 99:

"* * * the inner slag may have compounded with it vari-

ous metals or alloys, separate or combined, such as ferro-manganese, ferro-titanium, ferro chromium, ferro tantalum, ferro-tungsten, ferro-vanadium, carbon, etc., so that the inner slag, besides acting as a blanket, so to speak, to cover the deposited metal and prevent its oxidation from the
1990 atmosphere, may serve as a medium for carrying the alloying substances."

1991 Q. Now—pardon me. Continue.

A. (Continuing.) Then on page 2 he describes the use in line 22, as follows:

"The metallic core of the electrode is brought into contact with the metal on which it is to be fused by direct contact or some interposed conductive body.

"The metal core then starts to fuse and the inner coating is fused leaving the outer coating to form a shell or crucible-like structure, and in the crucible-like cup or tube thus formed, the metal core or inner slag is fused, the atmosphere being excluded by the crucible so that the fused metal is protected therefrom. There is an expulsive effect due probably to an arc throwing the molten metal away from the metal core, and the crucible or tube acts as a conductor or pipe by which the fused material is directed on the metal to be welded, patched or reinforced."

Then continuing in line 48 of the same column on page 2:

"The outer coating should just fuse at such a rate
1992 as to maintain a sufficient crucible and yet flow on to work sufficiently rapidly so that the arc if there be one, will not become too long."

Q. The third patent in this collection is No. 1,277,639, to Pescatore.

Will you very briefly explain what it discloses; and may I ask you preliminarily, is it a similar type of coated weld rod to that of each of the preceding patents?

A. Yes, sir, it is.

Q. Proceed.

A. This is an electrode for arc soldering. At line 16, Column 1 it reads:

"* * * covered with blue asbestos or with a layer of granular or powdered slag-forming material mixed with water-glass or some other agglutinant."

Q. What is water-glass?

A. Sodium silicate. Then on page 2, line 13, Column 1:

"The slag-forming material is made in the usual way.

preferably of a mixture that will on fusion yield a
1993 calcium and iron silicate, or a blast furnace slag, and powdered or granular ferro-manganese, aluminum, or any other material acting favorably on the steel or iron may be added thereto."

Q. Now the remaining patent is Jones, No. 1,441,685. Again, does this relate to a similar type of coated weld rod, I will ask you first.

A. Yes, sir, this is in the same art, and refers to the same kind of a slag-producing coating.

At line 16, on page 1, it reads:

"Various substances in which silica predominates, are used to form this casing for the electrodes, and among others may be mentioned, iron ore sand in the form of slag sand or slag wool, or in other convenient forms; asbestos formed into yarn soaked or smeared with silicate of soda and wound on to the electrode; mixtures of crushed limestone, carbonate of potassium and silicate of alumina, with or without magnesite or dolomite, or bauxite, and other materials, mixed into a paste with water or spirits, or a mixture of boracic acid, pumice stone, bicarbonate
1994 of soda, lampblack or powdered charcoal mixed with water, into either of which the electrode may be dipped so as to obtain a coating which is allowed to dry on but these mixtures, not being in the nature of a cement, readily break away from the electrode."

Then in line 52:

"* * * I may take for example three parts of finely powdered slag sand and one part of slacked lime mixed with a sufficiency of water, and to render the compound more tenacious I may add to the water for example a proportion of silicate of soda or other suitable silicious material."

Q. How is that coating treated after it has been applied in the manner which you have just noted?

A. It is dried.

1995 Q. Now there is a remaining collection of patents, to which I will next direct your attention, Mr. Yeomans, comprised in Defendants' Exhibit No. 145.

Have you reviewed all of the four patents in this set?

A. Yes, sir.

Q. In a general way what do they disclose in the
1996 way of a flux or welding composition?

A. They are pre-fused fluxes.

Q. The first one in the list is Armor, No. 1,467,825.

What are the components of the flux there disclosed, and just how are they combined, if, as you say, the flux is pre-fused?

A. Referring to line 20, on page 1—or rather, it is the only page of the patent—:

"* * * Or, I may use Zircon or any other natural form of Zirconium, together with an alkali or alkali earth."

And then again, at line 44:

"Thus, where mild steel is to be welded, I use a flux composed of silicates of iron, aluminum and manganese, together with, preferably, an alkaline substance or substances."

Then he says:

"In use, the composition is applied to the wire or rod which forms the electrode, and * * * The flux is fused and r[illegible]s"—

I am now referring to Line 76.

"—to float on the surface of the metal forming the 1997 weld, dissolving out the impurities in the metal, and by the formation of a protective coating, preventing the oxidation and the absorption of nitrogen from the atmosphere."

Q. And how are the ingredients for the composition noted, combined in the flux before it is thus applied, or used, in the welding operation?

A. They are fused together. Referring back to line 58:

"These elements are preferably fused together and then pulverized; or they may be merely pulverized and thoroughly mixed."

Q. Now included in the elements immediately above the quotation just read, is clay; is that correct?

A. Yes, sir.

Q. What is clay, chemically?

A. Clay is a silica-alumina mixture.

Q. Is it properly termed as a silicate?

A. Yes, sir, when it is fused it is.

Q. In this compound, is it fused?

A. Yes, sir.

Q. The next patent in this collection is No. 1,741,
1998 031, to Miller.

Will you similarly briefly note what it discloses in the way of a pre-fused flux, if such be the case.

1999 A. Miller outlines the necessity by saying, at line 24, page 1:

"The following are the desirable qualities of a flux for most welding operations. The flux should melt readily and its surface tension when molten should be such that it will readily adhere to the work as the latter is heated, instead of falling away or being blown away.

"A dense and quiet liquid will be more stable in the welding position than a very thin or frothy liquid, and the flux should therefore produce a liquid of this nature. As the temperature is increased toward the welding point the fluidity of the molten flux should not become so great as to cause undue difficulty in holding it where desired.

"The flux should be substantially nonvolatile at the welding temperature and furthermore should not evolve such quantities of gases, as by decomposition of its constituents or reaction among them, that the flux puffs or froths
2000 away from the surface of the molten metal. A flux of these properties will afford a protective blanket of maximum efficacy for the molten metal, and will protect the metal from oxidation throughout the entire temperature range where protection is desirable."

Q. What is the particular composition of the flux disclosed in the patent having these properties?

A. It is a glass; it is a boro silicate glass. He says in line 55:

"I have found that the above requirements are met in admirable fashion by a flux consisting of a boro silicate glass, such as the sodium glass."

Q. Would that be a metallic silicate?

A. Yes, sir. Then he goes on to say:

"The glass may be performed or materials may be subjected to the welding heat so that they react to produce the desired glass.

"The melting point of the glass will be depressed by increasing contents of alkali and boric oxide, while its viscosity and hence stability in the upper temperature
2001 range will be increased by raising the silica content.

"The boro silicate glasses when in the fused state undergo relatively slight change in fluidity throughout a wide temperature range, and this property is one of the principal causes of their effectiveness when used as welding fluxes."

2002 Q. In what kind of welding operation is this flux stated to be usable?

A. Well, fusion welding, which is the art that we are talking about.

Q. It is, is it not, stated at the beginning of the specification?

A. In the first line he says:

"The invention relates to fluxes for fusion welding."

Q. How obtained, the fusion, in the succeeding portion?

A. Either by the electric arc or the blowpipe flame.

Q. How is this prefused flux made? Is there any indication of that in this patent?

A. Yes. Line 95, page 1, says:

"A glass suitable for use as a flux can be cheaply and easily prepared by fusing ordinary borax, which is sodium tetraborate, crystallized with ten molecules of water, together with silica, the latter preferably in finely divided form, until a homogeneous frit results."

Q. How is the material then granulated? Does it describe that?

2003 A. Yes. He says at line 20, page 2:

"The fusion or frit is preferably poured into water, or onto a chill plate, and is powdered and applied to the weld in any suitable way."

Q. Now, turn to the third patent in this collection, likewise to Miller or Miller, et al., No. 1,748,785. Does it disclose a compound, a welding compound or composition similar to the one in the patent last discussed?

A. Yes. It relates to fluxing materials, and says, "particularly to fluxes adapted to autogeneous welding."

Q. Does that include electric arc-welding?

A. That is the art we are talking about.

Q. What does the flux here comprise? What are the constituents?

A. It says in line 37, page 1:

"Our flux consists, in essence, of the substances borax, silica and a fluoride, combined in a particular manner, which when so combined produces a flux having the desired properties."

Then again at line 45:

2004 "In the preparation of the flux of our invention we find it convenient first to prepare a boro-silicate glass by fusing together from 2 to 4 parts of ordinary borax and one part of silica, both materials being preferably in a finely divided form, and thoroughly mixed before fusion. The fusion of the two substances is desirably continued until a homogeneous melt results. To this melt may then be added about one part of lithium fluoride. This may be added to the melt while in the fused condition

or after cooling and grinding. In the former instance the material may then be cooled and pulverized. The preparation may desirably contain about 30% of SiO_2, about 40% of B_2O_3, about 15% of Alkali, and about 15% of fluorine."

Q. SiO_2 is what?

A. Silica.

Q. The next compound, B_2O_3?

A. That is boric acid, or boric oxide.

Q. Are there any other elements that lithium fluoride mentioned as adaptable for use in this composition?

2005 A. Yes. He says on page 2, line 29, column 1:

"We have above-described a preferred embodiment of the flux of our invention. We find however, that substantial modification therefrom is possible without departure from the spirit of the invention.

"The proportion of boric oxide may be varied within the range of 10% to 55%, and the silica over the range of 5% to 45% without loss of utility. The desirable range of fluoride substances is 10% to 50%. Other fluorides than the lithium fluoride may be used. A common fluoride substance is cryolite which is also suitable for inclusion in our flux. Other fluorides such as sodium and potassium fluorides are likewise suitable and the proportion of each may be varied according to the complexity of the welding undertaken."

Q. Let us proceed now to the remaining patent of this collection, No. 1,754,566, again to Miller.

A. 566?

Q. 566. What does it disclose in the way of a flux? First of all, does it disclose a prefused flux like the

2006 three preceding patents last discussed?

A. Yes. It specifies—in the first place, it refers to rods or the like for metal-depositing operations such as fusion welding. It says that rods prepared in accordance with the invention may be used in either the arc process or the blow-pipe process.

Now, he says at line 23:

"According to the present invention, the welding rod or the like is provided with a coating partially or completely enclosing it, the composition of the coating being such that a slag of molten manganese silicate will be formed during the welding or other depositing operation."

2007 Again, in line 33:

"* * * but the principal purpose of the coating is to produce a slag blanket which will prevent or diminish the loss of chemical elements from the deposited metal, prevent or diminish absorption by the metal or atmospheric and combustion gases, and promote the deposition of the metal in a clean, sound, and homogenous condition without unduly taxing the skill of the welder."

Q. Is there any reference in the patent to other modes of using this prefused welding composition, than by applying it as a coating on the weld rod?

A. Yes. At the top of the second column, page 1, he says:

"The invention may be embodied in a rod having a coating of manganese silicate applied thereto in any suitable way as by powdering it, mixing the powder with a binder such as dilute alcoholic shellac, immersing the rod in the mixture, and then withdrawing the rod and allowing the adherent material to harden."

Q. That describes the application of it as a coat-
2008 ing; but may I direct your attention to the third page. Is there any indication found there of intended other uses?

A. Yes. He says:

"The foregoing description refers specifically to rods or electrodes having an external coating of slag-forming materials. A hollow rod containing the slag-forming materials as a core gives the equivalent of the externally coated article, and may be regarded as an internally coated rod. The appended claim is intended to embrace all rods or the like wherein an elongated metal member and an elongated body of slag-forming material are so juxtaposed that additional slag or flux is automatically supplied as the extremity of the metal member is fused away.

"The compositions described herein for coating welding rods or electrodes can also be used, though usually not so advantageously, in forms other than a coating or core. They may, for example, be used in the form of
2009 powder into which the hot rod or electrode may be dipped, or they may be applied to the weld in any other suitable way. The use in welding of the compositions claimed in the appended claim"—

Mr. Oberlin: That is immaterial.

By Mr. Oberlin:

Q. Mr. Yeomans, one of the patents previously offered in evidence as showing the state of the prior art, and anticipatory of the alleged invention of the patent in suit, is Lincoln Patent No. 1,589,017, Defendant's Exhibit 104.

Will you now refer to that patent and, in connection with your consideration of it, also note Defendants' Exhibit No. 139 for identification.

2010 What does this patent disclose in the way of the method or process of electric welding, and of a flux or composition of matter suitable for use in connection with it?

A. This patent refers to the protection of the weld material while being deposited, afforded by gases, inert gases about the arc, or a slag protection, or both.

He says, line 38, page 1:

"I have ascertained that in order to obtain ductility in a weld, it is necessary to avoid as far as possible, the oxidizing action of the air, and this I have accomplished by using both an inert gas about the arc, and a protective medium for the weld, which I may term a slag."

Then at line 56:

"In connection with said inert gas, moreover, I may employ a slag covering for the welded seam, or this may be used independently for the purpose of excluding the air from the welded seam during its production. The material forming such slag is melted by the ex-
2011 cessive heat of the arc, floats on top of the molten metal and serves as a protection therefor, which in conjunction with the inert gas, serves as an additional protection against oxidation and the result is a weld of such improved quality as to be sufficiently ductile for all practical purposes."

Then on page 2, line 124:

"As indicated respectively in figs. 1 and 13, the welding operation may initially embrace either a portion of, or the entire thickness of the sheets to be welded, although the latter contemplates complete welding at a single operation, and consequently may be accomplished more rapidly than when intersecting welds must be formed from opposite faces of the metal."

On page 3, line 3:

"The sheets a b are positioned with their edges substantially in abutment, as shown in figs. 2 to 6. A strip

c or wire d of steel or alloy, such as nickel-steel or chromium-steel, for example, is placed adjacent to
2012 the abutting edges, and the flux e is supplied to cover the parts, as in fig. 4. I may use asbestos, sodium-carbonate, borax or other suitable materials for the flux; the requisite thereof being that it will persist beneath the electric arc in sufficient volume to cover and exclude the air from the molten metal."

Q. The reference, I believe, thus far has been apparently to a method of arc welding in which a carbon electrode is employed, is that right?

A. That is right.

Q. Is there any indication or teaching in the patent that a metallic rod can be used instead of a carbon electrode?

A. Yes. Page 3, line 68 says:

"Preferably, the plates a b need not be specially prepared for welding, but are disposed with their edges in abutment, or in opposition to each other. The arc is then struck, its action is carefully observed and the electrode, which may be either of carbon or metal, is progressively advanced along the seam as rapidly as the welding is accomplished."

2013 Then on page—

Q. Just a moment. Will you refer to the drawings and point out in which figure the arrangement whereby flux is placed—or slag, as it is called—along the line to be welded is illustrated?

A. Fig. 4 of the patent shows that, and—

Q. What does Figure 5 show?

A. Figure 5 shows the completed weld, with the weld metal illustrated by a' and the molten and solidified slag represented by e'. That e' corresponding with the windrow of slag designated as e in Figure 4.

2014 Q. In the second figure that has become fused?

A. Has been fused and has become solidified.

Q. Turn now to the Robinoff Patent No. 1,782,316, already in evidence as Defendants' Exhibit 103; and in this connection may I also call your attention to the chart, Defendants' Exhibit 140.

Similarly, will you describe the process, if such be described, that is disclosed by this patent, and tell how it is intended to operate.

A. It relates to methods of welding, and he describes the carrying out of his method at line 33, page 1:

"In carrying out our method the edges of the plate or plates to be welded are first chamfered and then brought into an abutting position to form a U or V-shaped groove along the line of weld. The plate or plates are then positioned over a suitable backing up bar standard welding apparatus and clamped in their abutted position. The groove is then filled with a powdered flux composition having a percentage of ground or powdered scale (ferrous oxide) to make the flux Magnetizable.

"After the groove has been welded with flux the welding head of the welding machine, having a reel of welding rod or electrode wire thereon, is started in operation to feed the electrode down into welding position with respect to the flux filled groove and also to feed the electrode longitudinally of the groove. After the electrode is brought into proper position an arc will be struck so as to melt the flux in the groove and also to melt the metal of the electrode so as to furnish a deposit of metal in the groove.

"As the welding operation progresses the welding rod will be continually melted and deposit the molten metal through the molten flux in the groove, and the metal being of greater specific gravity than the molten flux will cause the flux to rise in the groove as the metal is deposited. The movement of the welding head is so timed that the proper amount of molten metal will be deposited to fill the groove the desired amount as the head passes along the groove.

"In carrying out this method the molten metal deposited from the electrode is at all times covered by a layer of the flux in the form of a slag and therefore the deposited metal from the electrode will remain molten a sufficient time to permit any entraining gases to escape and the deposited metal will not become oxidized since the flux or slag protects the molten metal from the atmosphere."

On page 2, line 19:

"The operation of welding from this point may be carried out in several ways all of which retain the one fundamental feature of maintaining a relatively heavy coating of flux or slag 9 on top of the molten welding metal and through which the molten metal is deposited so as to prevent oxidation of the metal."

Then on page 2, the second column, line 78:

"In Figure 3 a modified method of this invention
2017 is disclosed. In this modified method the electrode 12 is caused to move down into the body of flux 9 and is then moved forward at a speed to maintain the electrode in close position relative to the flux thereby causing said flux to be melted directly by the arc."

2018 Q. Referring to the chart exhibit, which of the several forms illustrated in the patent—forms of operation or arrangement of the flux and the weld rod—does it illustrate?

A. The first method describes it. That says, in the specification, line 83, page 1:

"Figure 1 shows the edges of a pair of plates with a finished weld joining them and with the flux or slag covering the welded joint."

Q. But as to the disposition of the flux and of the weld rod, in relation thereto in the chart, which is the arrangement shown, does that correspond with figure—

A. That corresponds with figure 2.

Q. Figure 2, or figure 3? Will you note the position of the end of the electrode?

I merely wish to clarify the showing of the chart.

A. That is right. The position of the electrode is as shown in figure 3.

Q. In other words, the complete section is shown but with the electrode disclosed as in figure 3, is that right?

2019 A. That is right.

Mr. Oberlin: Mark this for identification.

(Whereupon an article was marked Defendants' Exhibit 148 for identification.)

By Mr. Oberlin:

Q. You have heard the discussion by the defendants' witness, Mr. Robinoff, of the operations, electric welding operations, carried on in the so-called Christie Park plant of the National Tube Company?

A. Yes, sir.

Q. Are you familiar with this article which was published in Iron Age, issue of May 7, 1931, entitled "New Pipe Mills at McKeesport Works of National Tube Company", and marked for identification Defendants' Exhibit 148?

A. I am familiar with it.

2020 Q. Does the article bearing the title which I quoted include a description of a welding operation purportedly carried on in the plant in question?

A. It does.

Q. Will you note where in the article such description is given?

2021 The Witness: The second paragraph of the first column of page 1505; the second paragraph of the second column of the same page; then the start of the next paragraph, consisting of three lines on that page, and a completion of it in the next five lines on page 1506; and the following—

Mr. Oberlin: May I ask the witness to take—pardon me.

The Witness (continuing): —the following two paragraphs in the first column, on page 1506.

Mr. Oberlin: If the Court approves, may I have the witness mark on the margin with a pencil line the paragraphs he has just indicated containing the description inquired about.

2022 By Mr. Oberlin:

Q. Will you now return to the Miller Patent No. 1,748,785, previously discussed by you, Mr. Yeomans.

A. Yes.

Q. Have you seen any welding done with a flux having a composition made in accordance with the teaching of this patent?

A. I have.

Q. Where and approximately when?

A. At the Lincoln laboratories, by Dr. Booth, on December 27th.

Q. Was a sample of the flux then used preserved?

A. Yes, sir.

Mr. Oberlin: I will ask the Reporter to mark this as Defendants' Exhibit No. 149 for identification.

(Whereupon said article was marked Defendants' Exhibit No. 149 for identification.)

Mr. Oberlin: I may state that the container, the sealed container marked "Miller Flux, 12-11-46, M. R. Taylor" is a duplicate sample of that which we sent to counsel

2023 for Plaintiff in accordance with the pre-trial notice.

I will ask that this plate be marked for identification as Defendants' Exhibit No. 150.

(Whereupon said article was marked Defendants' Exhibit No. 150 for identification.)

By Mr. Oberlin:

Q. Can you identify on this plate which I call to your attention, which has been marked for identification as Defendant's Exhibit 150, a weld produced on the occasion to which you referred?

A. Yes.

Q. There are several welds or beads laid on this plate.

A. Yes.

Q. Which one is it that you thus identify, and how is it marked on the plate?

A. It is the second one from the top as I hold the plate in readable position.

How is it identified?

Q. Yes.

A. It is stamped "Miller" at the end.

2024 Q. Did you personally witness the laying of that bead?

A. I did.

Q. With flux, the composition of which is that in the sample here produced?

A. That is right.

Q. Does this plate carry any other indicia showing the conditions under which the bead in question was made?

A. Yes.

Q. Do those correctly record those conditions, and if so, state what they were.

A. The plate shows 550 amperes, 30 volts, 14 inches per minute and the date. That checks with my notes made at the time, with the exception that I have additional notes as to 3/16ths diameter electrode and reverse polarity.

Q. Do you recall seeing silica sand used in a demonstration over at the Graver plant two days ago, I believe?

A. Yes, sir.

Q. What is the melting point of silica sand, assuming it is substantially pure? I believe the analysis of that sample was 99 plus.

2025 A. I think about 1800 degrees. I can look it up, if you want it accurately.

Q. That is near enough. That is Centigrade?

A. Centigrade, yes, sir.

Q. How does that compare with the melting point of the steel in the plates that were being welded there, if you know?

A. About 300 degrees Centigrade higher.

The Court: Which was higher?
The Witness: The sand is higher.

By Mr. Oberlin:

Q. Have you ever seen the Plaintiff's—that is, the Linde Company's—so-called Unionmelt process in operation, Mr. Yeomans?

A. Only in the demonstration before this Court.

Q. Those were on two separate days at the laboratory of the Linde Company in East Chicago, I believe?

A. That is right.

Q. You attended those?

A. Yes, sir.

Q. And those are the only demonstrations that you have seen of the so-called Unionmelt process?

A. As far as my knowledge goes.

Q. That is, where you had it identified to you?

2026 A. I may have seen it as I walked by it, but not knowing what it was, not paying any attention to it.

Q. What is the heat producing agent whereby the electrode and work piece are fused and the weld produced in that Unionmelt process?

A. An electric arc.

Q. Did you ever see any process wherein such fusion and weld are obtained by the use of a conductive melt and the resistance afforded thereby to the passage of current through the melt?

A. No, sir.

Q. Assuming that an arc is established between the electrode and work piece in a welding operation such as in the Lincolnweld process, can that arc be maintained and any consequential volume of current be conducted through any other path?

A. No, sir.

Q. Is that true if the path be a molten body of flux such as is used in that process?

A. That is true in every case.

Q. Can you indicate what volume of current, if any, would pass through such a molten body of flux while an arc is maintained between the electrode and the work

2027 piece?

A. It would be infinitesimally small compared to the current passing through the arc.

Q. That is, assuming that such body of flux, or as it has been called, molten pool, as may be formed by fusion

of the flux, the granular flux, by any chance is brought into contact with the end of the electrode, what would be the volume of current conducted through such flux in contradistinction to that conducted through the arc?

A. Just enough current would be conducted through the flux to vaporize an insulating layer of it next to the electrode, which would be a very, very small fraction of a second.

Q. If such contact were possible between the body of molten flux and the electrode and work piece, as to carry any substantial volume of current, what would happen to the arc?

A. It would immediately cease to exist.

Q. Is it possible, in other words, for an arc to exist and at the same time any substantial volume of current be conducted through flux thus in contact with the electrode and work piece?

A. No, sir.

2028 Q. Have you made calculations of the current density in a welding operation such as where the Lincolnweld process is carried out?

A. Yes.

Q. Are the answers which you have given based on such calculations and your general knowledge of the conductive characteristics of an electric arc versus any other medium?

A. They are.

2029 Mr. Oberlin: At this time, if the Court please, I offer in evidence the exhibits marked for identification and not heretofore offered during the examination of this witness.

Mr. Cahill: I have no objection to so much of this plate as has been identified, the weld made by Miller. I do object to the rest of it.

The Court: The other has not been identified.

Mr. Oberlin: The other has not been identified and the plate is offered only in so far as the bead or weld thereon is identified from the testimony of the witness.

2030 Mr. Cahill: It goes in only as to the weld allegedly made by the Miller flux, as I understand it.

The Court: Yes. Admission will be limited to that.

Mr. Cahill: Yes. If I understood Mr. Oberlin correctly, he also says he was moving the admission of all ex-

2031 hibits marked during the direct examination of this witness.

Mr. Oberlin: That is correct.

Mr. Cahill: I do not understand he is reoffering those as to which specific objections were sustained.

The Court: I think it would facilitate matters if you make your offer specifically after you have received the transcript and you can see what has been admitted and what has not been admitted, and what has been rejected. In the meantime I suggest you refrain from pressing your offer until you have had an opportunity to examine the transcript.

Mr. Oberlin: We will do that after the noon recess. The ones which I intended to offer at this time were those which were identified, and either not objected to, or had not been rejected.

2032 *Cross-Examination by Mr. Wolfe.*

Q. Mr. Yeomans, you broke off your schooling at a rather early age to start your machine shop apprenticeship, did you not?

A. That is right. Fourteen years.

Q. You have had no formal education in chemistry, have you?

A. That is correct. No formal education in anything since then.

Q. That would include metallurgy or chemistry?

A. That is right.

Q. Have you ever done any welding yourself?

A. No, sir.

Q. After you left school at 14, then you went to work as a machine shop apprentice, did you, or a machinist's apprentice?

A. That is right.

Q. When did you finish your apprenticeship?

A. In 1897.

2033 Q. Then I believe you told us that you worked for a number of years after that as a journeyman machinist and die maker, was that right?

A. That is right.

Q. In the years that have followed you have done a great deal of machine tool design, have you not?

A. Oh, not too much. You have taken out patents on about twenty of them, but that is only a small part.

Q. It covers a great variety of special machine tools of various kinds?

A. Not a great variety, no.

Q. Well, name some of them, please, for us.

A. Well, a complete line of shell-making machines and gun boring machines for World War I, and a line of machinery of about the same type for World War II, and perhaps eight or ten other patents besides those in that time.

Q. You have also occupied yourself with the management and operation of machines and machine shops, have you?

A. That is quite possible.

Q. Have you ever conducted any tests or experi-
2034 ments in determining the conductivities of molten welding compositions of the types we have been talking about?

A. No, but I have had them conducted under my direction.

Q. What experiments did you do of that kind?

A. Oh, hundreds of them, at A. O. Smith Corporation. I cannot recall them all. I used to check with Langstroth and read the results, but they have entirely escaped my recollection now and I have no record of them. But there were plenty of them.

Q. Have you done any in preparation for this suit?

A. No, I have not.

Q. Well, now, if you took a pot full of this Lincoln 660 flux and fused it and put a regular welding electrode wire down in it, could you pass sufficient current from that wire through that fluxing material to generate heat for melting the wire without vaporizing the flux?

A. No.

Q. You are absolutely sure of that?

A. If I understand the question correctly—perhaps I had better have it read.

The Court: Read the question, please.

2035 (The question was read.)

Mr. Oberlin: If the Court please, the question is indefinite in that it does not indicate whether the weld rod is a stationary weld rod or wire, whether it is merely suspended in a pool or pot full of molten flux, or whether it is supposedly moving as is the case in the welding operation. I think the witness should have a clarified statement.

By Mr. Wolfe:

Q. Will that cause you difficulty, Mr. Yeomans?

A. Why, yes. The molten flux could be heated to a point that would melt the rod when you put it in it, whether there was any current going through it or not, if you heated it on the order of 5,000 degrees.

Q. We can go still further, as a matter of fact. You can pass sufficient current from the wire through the flux to keep it molten and continue to melt the wire, can you not?

Mr. Oberlin: Does this question postulate a stationary wire, or a moving wire or electrode as in the process
2036 we are here concerned with?

Mr. Wolfe: I will let the witness put in any qualification he needs to, to understand it.

A. I do not know.

By Mr. Wolfe:

Q. You do not know—

A. No.

Q. —whether it would be possible?

A. No. I do not know the answer to that question.

Q. What is your opinion?

A. I have not any opinion in answer to that question.

Q. You are not able to form any opinion?

A. Not on that question, no, sir.

Q. As to whether that would be possible?

A. No.

Q. Did you ever try anything of that kind?

A. No, not that.

Q. Have you tried anything similar?

A. No.

Q. Now, according to my notes that I made here as you were concluding your direct examination I understood
2037 you to testify that if in the Lincolnweld process you had some contact between the pool of fused flux and the electrode, that nevertheless any current that passed from the wire through the liquid material would be inconsequential.

A. That is right.

Q. Is that the gist of your testimony?

A. That is right.

Q. In fact, I think you said it was infinitesimally small?

A. That is right.

2038 Q. Well now, if it is as small as that you would not be able to take a pair of probes with a volt-

meter connected across them and measure any voltage drop between space points in that pool, would you?

A. I would not expect to.

Q. And you would not be able to connect one terminal of the meter and the wire and the other to a rod placed down in the pool and measure any voltage drop, would you?

A. I would not expect to see much.

Q. And if you did get a measurement of, say, two or three volts that would be completely incompatible with this idea of infinitesimal current, would it not?

A. No. Voltage would not have anything to do with it.

Q. A voltage drop would not be a measure or an indication of the value of current?

A. No.

Q. Or the order of magnitude of the current?

A. No.

Q. Have you made any independent investigation of this matter of whether or not there is in the Lincolnweld process contact between the electrode or wire and
2039 the pool of fused flux?

A. I know there is not.

Q. You just knew that?

A. There cannot be.

Q. So you did not make any experiments as to that?

A. No, sir.

Q. You did not, for example, take any high speed motion pictures to satisfy yourself on that?

A. No, sir.

Q. You did not try using hollow electrodes with either suction or pressure applied?

A. I did not try any means to determine that.

Q. What is your opinion as to whether or not there is any similar contact between pool of flux and electrode, in the Unionmelt process?

A. The same.

Q. And your conviction with regard to that is just as firm as it is as to Lincolnweld?

A. Exactly.

Q. When was it that you first saw the Lincolnweld process in operation?

A. Why, as far as my knowledge goes, it was at the Graver plant in May, last May.

Q. And you stated, I believe, that you had been
2040 out there once since that time?

A. Yes, sir.

Q. Upon what date?

A. That was in November—well, just a moment, please. That was shortly after Mr. Fishleigh was out there, if you can give me that date.

It was November 27th.

Q. Were you there at any other times?

A. I was there at the demonstrations which were given before the Court the other day.

Q. Any other times, beyond that?

A. Yes, sir. Thirty-two years ago I put in a report on that plant, sir.

Q. But you have not seen the Lincolnweld process—

A. I have not seen the plant since.

Q. Where else, besides there, have you seen the Lincolnweld process?

A. I have seen it in the Lincoln laboratories, and in the demonstrations which were given before the Court.

Q. You have not seen it in any other factories, that you know of?

A. Why, not to my knowledge. I might have seen it, but paid no attention to it.

2041 Q. How many times did you see it in the Lincoln laboratories?

A. Oh, two or three times—three times, I guess; yes, three.

Q. And for how long a period of time on each occasion?

A. Oh, perhaps an hour or two, but not as much as half a day, however.

Q. That was down in Cleveland, was it?

A. Yes.

Q. What was the largest size of plate which you saw welded on any one of those occasions?

A. Well—

Q. The plate of the greatest thickness, I mean.

A. Oh, I don't know; $\frac{5}{8}$ths of an inch, perhaps, or $\frac{3}{4}$, or perhaps one inch.

Q. Do you remember, over at one of the demonstrations which we made before the Court, that a one inch plate was welded?

A. Yes, I guess it was.

Q. When did you first see at any time, with any process, a one inch plate welded with a single pass?

A. Oh, I don't know that I have ever seen it.

Q. Well, you remember the one at the demon-
2042 stration, do you not?

A. Well, I don't remember whether it was a one inch plate or not.

Q. Well, we have it right here on the floor—

A. I presume it was.

Q. —if you desire to refresh your recollection. I think that this is Plaintiff's Exhibit 148. Would you like to look at it again, to refresh your recollection?

A. No, I don't have to refresh my memory on it. I saw the plates that were welded over there, and if that is one of them, then that is the same plate. If it was the one inch plate, it was a one inch plate.

Q. And you never before that, as far as you know, had seen a plate that thick welded in a single pass; is that correct?

A. Oh, I might have, I never paid any attention to the plate, sir. I might have, but I don't know.

Q. What is the thickest plate of which you have any definite recollection, of having seen welded in a single pass with a coated rod?

A. I wouldn't be able to say.

With a coated rod, did you say?

2043 Q. Yes.

A. I wouldn't be able to say.

Q. You do not have any information?

A. No.

Q. No definite information?

A. No, sir. I have seen thousands and thousands of them welded, but I wouldn't know at the present moment whether any of them were welded with a single pass or not.

Q. Do you know anything about the values of currents that were commonly employed in hand welding?

A. Yes, sir. I think that the average would perhaps be about 300 amperes, in hand welding.

Q. Now will you look with me—

A. (Continuing) —or perhaps less than that; perhaps 200—200 to 300.

Q. Will you look with me, in the patent in suit, at page 3, if you have your copy with you of that there?

A. Yes, sir, I have it.

Q. There is a table boxed in there on page 3,—do you

see that?—and the right-hand column of it is headed "Old Methods", and it gives current values there
2044 for different sizes of electrode.

A. Yes.

Q. Those are, as a matter of fact, representative current values for these sizes of electrodes in hand welding, are they not?

A. Well, but it does not say what old methods. I would say, that was one method, for the hand electrode.

Q. Have you ever seen the Lincoln Company's boxes for their Fleetweld rods?

A. What do you mean, the metal boxes?

Q. The ones that they ship them in.

A. Well, yes, sir. I laid out a factory to make them, once.

Q. Well, that is the same table of values that they put on those boxes, is it not?

A. I wouldn't know.

Q. Now, you told us this morning of this weld that is supposed to have been made with some reproduction of flux from the Miller Patent.

As to all of these other fluxes in this series of patents which you went over, have you conducted tests of each of those fluxes?

A. Oh, no.

2045 Q. Or any percentage of them?

A. Not any of them, no, sir, except there are some welds there on the same plate, that were made with Robinoff flux.

Q. That is the only one?

A. Yes, sir—well, no; I don't think any of them that were in the patent—I have seen some tests made with silicate flux, but I don't know that they were any of them ingredients of any patent I have described.

Q. Well now, if I were to tell you that the Plaintiff has tried each of those that are described in the patents, and found that none of them would make a satisfactory weld, would you be surprised?

A. Not at all.

2047 Q. Now, Mr. Yeomans, I want to call your attention to Defendants' Exhibit No. 150. You referred to that, I believe, as a bead that you put down with the Miller flux.

A. Yes, sir.

Q. Did you make any actual butt welds, that is, joinings two plates—

A. No.

Q. —using that material?

A. No, sir.

Q. In this bead there are fine transverse and longitudinal cracks, are there not?

A. There may be.

The Court: Let me see that sample of flux, please.

Mr. Wolfe: Yes, your Honor.

A. (Continuing) I cannot see them.

By Mr. Wolfe:

Q. Have you had any X-ray examination made of that?

A. No, sir.

2048 Q. Have you examined it closely with a magnifying glass?

A. No, sir.

Q. Oh anything of that kind?

A. No.

Q. It is a fact, is it not, that a crack of any kind disqualifies a weld for all specifications?

A. Yes—all pressure specifications.

Q. The presence of even fine cracks in the weld would cut its physcial properties down to the point where you get practically no tensile strength reading on a specimen, or ductility either; is that not so?

A. Yes, sir.

2049 Q. Have you ever made any tests of the physical properties of any welds made with your attempted reproduction of the Miller flux?

A. No, sir.

Q. In referring this morning to the several applications which finally matured in the patent in suit, you characterized the second one, I believe, as disclosing what was, in your opinion, a welding process that was entirely different from the process of the first; is that correct?

A. That is right.

Q. And were you speaking at that time of the second application as it was filed, or at some other period during its pendency, or would you draw any distinction in any of them?

A. As it was filed.

Q. And was there some later period when you would change that characterization?

A. No, I don't think so.

Q. In arriving at that opinion, did you have in mind the fact that the sentence in the second application, as originally filed, read:

"Several circumstances show clearly that our
2050 process does not depend upon the formation of an arc", that that sentence was subsequently amended by the addition of the words "of the usual type"?

A. No, I know there were some amendments like that.

Q. You did not have that in mind when you formed that opinion as to difference?

A. I had in mind the way it was filed.

Q. And you did not have that amendment in mind?

A. Yes, I had that amendment in mind.

Q. Did you also have in mind, when you formed that opinion, the fact that, coincidental with that amendment, the following statement was made by the attorneys who filed the amendment—and I quote:

"'Applicants' specification has been slightly amended where it discusses the theory of their process, and compares this process with prior art processes. It is immaterial to the patentability of the invention whether applicants are able to give the correct theory or not, but it is their purpose to give the Examiner the fullest information in their possession on this matter. It is
2051 difficult, if not impossible, to define an arc precisely, and applicants have contemplated the possibility that a definition may be framed in such terms as to embrace the phenomenon which occurs in their process. There can be no question, however, that there is no such arc involved in their process as occurs in every prior art process, including that of Robinoff et al. Anyone, if he bears in mind the intense dazzling arc which less than fifty amperes will evoke and stands by one of applicants' machines and sees a weld made with 2,000 amperes but with little or no visible evidence that a heating operation is being carried on, will quickly be convinced that here is something quite different from any arc-welding process known to the art."

Did you have that in mind?

A. Yes, I had all those statements in mind.

Q. Did you also have in mind the fact revealed by the file wrappers here that the process claims were
2052 all allowed after that statement which I have last read was made to the Patent Office?

A. Yes. I have that in mind.

Q. What is a file reference in common patent parlance or jargon, Mr. Yeomans?

A. A reference?

Q. A file reference.

A. Oh, to some patent that either limits or anticipates the subject matter that is claimed.

Q. A file reference is a prior art patent that the Examiner cites in some action—

A. That is right.

Q. —that he gives in the case, is it not?

A. That is right.

Q. In this file wrapper which you state you had studied there are letters in the Patent Office, and in those the Examiner lists the patents that he has considered, is that right?

A. Yes. I know those references.

Q. Among those is the J. C. Lincoln Patent, No. 1,589,017 that you discussed this morning?

A. That is right.

Q. Do you have your chart on that patent there before you?

2053 A. Yes, sir.

The Court: What is the number of that Mr. Wolfe?

Mr. Wolfe: Defendants' Exhibit 135. I am sorry.

By Mr. Wolfe:

Q. The particular set up that is illustrated in the drawings from the patent that you have put on your chart here, Mr. Yeomans, is one where a carbon electrode is used, is that right?

A. That is right.

Q. And whether carbon or metallic electrode, the set up is one for open arc welding, is it not?

A. I do not understand the term "open arc welding."

Q. Well, if you will look with me at the right-hand one of the three Figures of your chart, it is evident there, is it not, that the arc is exposed between the tip of the electrode and the plate so it will be plainly visible?

A. Yes. It is uneoncealed.

Q. And you would have a dazzling, blinding glare

2054 from that arc, would you not?

A. Well, you would have whatever glare there was due to the voltage and the current.

Q. It would look about like these demonstrations of hand welding that both the Plaintiff and Defendants have put on for the Court, would it not?

A. Yes. You could not look at it without eye protection.

Q. A carbon arc, if anything, is brighter than a metallic arc, is it not?

A. Whiter.

Q. You referred this morning to the directions from that patent for using what the patentee calls an inert gas and referred us to page 1 of the specification in the first column.

Now, in line 45 the patent says:

"The inert gas, such as nitrogen or carbon dioxide, for example, may be supplied to the arc in any suitable manner."

What is meant by an inert gas in that instance?

2055 A. One that is not reactive: He speaks of nitrogen, or carbon dioxide.

Q. Now this patent was applied for back in 1918, and at that time the people of the welding field thought that the greatest danger to the weld lay in oxidation from the air, did they not?

A. Yes—and also nitrogen.

Q. What happens when you get nitrogen into a weld?

A. You are likely to have nitrides, which are large, needle-like crystals.

Q. Resulting in very poor weld properties?

A. Yes—brittle properties.

Q. So that supplying nitrogen to the weld would inevitably promote the formation of those nitrides, would it not?

A. Well, I would think so, yes, sir. It is not done practically.

Q. Now in the case of carbon dioxide, the other gas which he mentions there:

If carbon dioxide is applied to molten steel, it will 2056 oxidize it, will it not?

A. No, sir. It may pick up some more carbon; if the steel has much carbon in it, it would pick up carbon, and make carbon monoxide.

It would reduce the oxygen. You would have two molecules of carbon monoxide, and you might pick up an additional atom of carbon.

Q. Now have you thought this over carefully, Mr. Yeo-

mans, as to whether or not carbon dioxide would be oxidizing in the presence of molten steel?

A. Under some circumstances it is, and under other circumstances it is not.

Q. Well, under the circumstances which you have in the puddle of molten steel, in an arc weld—let us take those circumstances—is it oxidizing there?

A. Yes, sir, I think so.

Q. So that—

A. (Continuing.) That is, if the carbon is low.

Q. So that these two so-called inert gases that he suggests would both be about as poor as anything you could think of, to put on there, would they not?

A. Oh, there might be better ones, such as argon, and helium, and some of the more expensive ones.

2057 Q. Then over on page 3 of this patent, you called our attention to the first full paragraph in the patent, where he is talking about the flux, as shown in figure 4 of his drawings, and where the patentee says:

"I might use asbestos, sodium carbonate, or borax."

Now, have you tried any one of those three as a substitute for the Lincolnweld 660 flux?

A. No, sir, not as a substitute. I have never tried any 660 flux, except just in the use of it.

I have never tried to devise something that was exactly the same as the Lincoln 660 flux,—if that is what your question means.

Q. So that you do not have any information with respect to how bad the weld would be, if you tried to substitute one of those?

A. Oh, I know that a weld made under blue asbestos is a beautiful job, and always has been.

Q. It is your opinion that it would be quite feasible to substitute blue asbestos for the Lincoln 660 flux, is it?

A. Yes, sir, I think so. I think it would make a beautiful job. If the blue asbestos was fused, and ground
2058 up, granulated, the same size as the Lincoln 660, I think that it would do just as good a job.

Q. And do you think that you would get an equally beautiful job if you used sodium carbonate?

A. I don't know; I don't think so.

Q. Do you think that you would get an equally beautiful job if you used borax?

A. Well, in combination with other things. I think that either—

Q. Well, now, just a moment, please. Let us stick to borax.

A. Well, not straight borax, no, sir; I don't think so, no, sir.

That is borium oxide, I take it.

Q. Now, returning to the so-called inert gases that Mr. Lincoln speaks of in his patent:

How are those applied to the weld?

A. Why, the patent says they are applied through a hollow electrode.

Q. In other words, you sort of squirt the gas down around the arc, do you?

A. You force it through the center of the electrode.

Q. And that is not a liquid; that is a gas, that you are speaking of?

2059 A. That is a gas.

Q. I suppose you might call it a fluid?

A. Technically, it is a fluid.

Q. That is, the term "fluid" commonly embraces both liquid and gas, does it not?

A. Technically, it is a fluid.

Q. Now will you turn with me, next, please, Mr. Yeomans, to this other chart of yours, on the Robinoff patent.

A. Yes, sir.

Q. No. 1,782,316, Defendants' Exhibit 140.

A. Yes, sir.

Q. Now then, in the setup that is illustrated there, you have taken two of the figures from the Robinoff patent, and reproduced them on your chart, but I see that you have left off the reference numerals, or letters, in patent, and substituted your own legend therefor; is that right?

2060 A. Just a moment, please. I don't think that those are taken from the Robinoff patent.

Q. Oh. These are some figures which you have made up yourself, then, are they?

A. No, sir, I didn't make them up. I think that those were made up by Mr. Robinoff some time ago.

Q. Well, what is the representation, then, with respect to this chart?

A. Pardon me?

Mr. Wolfe: When it came in this morning, I understood from the caption on it, and so forth, that this was taken from the patent.

Is this something of unknown origin, now, Mr. Oberlin?

The Witness: Well—

Mr. Wolfe: Just a moment, please, Mr. Yeomans. I am directing that question to Mr. Oberlin.

Mr. Oberlin: It was taken from the patent, obviously, in accordance with the directions in the patent, and the drawings, which the witness explained this morning,—the combination of figures 2 and 3. Figure 3, that is,
2061 has been extended as it would be if it were carried as far as Figure 2.

Mr. Wolfe: Well then, I will move to strike out this material as not something that this witness prepared, and it does not match the patent.

The Court: It does not do what?

Mr. Wolfe: I say, it does not match the patent.

The Court: Well, as I understand it, from what this witness stated this morning—although I do not know who made it—this left-hand Figure is altered from the patent figure, in that the electrode is down in the flux, as it is in another Figure in the patent.

Mr. Oberlin: That is correct.

The Court: And that is the only difference in representation between this, and the patent drawing.

The Witness: Your Honor, may I explain?

The Court: No. How is it incompetent, because of an alteration of that sort, if it is explained?

2062 Mr. Wolfe: Well, just so long as the record is clear as to what this thing is, your Honor; that is my only point.

By Mr. Wolfe:

Q. Is that the fact, Mr. Yeomans?

A. If I may explain, I can settle the whole thing by saying that I was looking at a different chart, and not the one that you are talking about.

You are talking about this—I do not have the exhibit number here, but you are talking about the Robinoff process patent, No. 1,782,316; that is what you are talking about.

Q. Yes.

A. And what I am talking about is the Robinoff process original disclosure.

Mr. Oberlin: And that is not an exhibit at all.

The Witness: No.

Mr. Wolfe: All right. Then will you look at our chart of the Robinoff Patent.

The Court: You are starting over, now?

Mr. Wolfe: Pardon me?

The Court: You are starting all over?

2063 Mr. Wolfe: Yes.

By Mr. Wolfe:

Q. On this chart of yours, Defendants' Exhibit 140, did you prepare the figures which appear at the top of it?

A. No, sir.

Q. Did you have them prepared?

A. No, but I saw them being prepared, and I know that the captions that are put on there are put on to make it easier reading and to refer to the patent. I know those are the patents.

Q. How do they compare with the illustrations in the patent itself?

A. The electrode is shown at the position of Figure 3 of the patent, and the electrical connections are not shown. The section view is Figure 1, and is identical with it.

Q. Now, you have not applied any legends to the horizontally dotted portions of material that appear at the lower end of what is marked "electrode", have you?

A. No, but that is what is marked "y" in Figure 2 of the drawings and in Figure 3.

2064 Q. And another part of it is marked "x". Will you on the chart, please, apply the reference letters x and y to the corresponding parts just as they are in the patent?

A. I have done so.

Q. Now, the patent says, on page 2, down about Line 56 in the first column, that x is molten flux and that y is a pool of molten welding metal, is that right?

A. That is what it says.

Q. Now, actually, of course, the tip of the electrode couldn't possibly be in the molten metal could it?

A. It could if it was short-circuited.

Q. Well, it couldn't be there in the welding operation?

A. Not in a welding operation, no, sir.

Q. So we can't take that illustration as being indicative of what the set up is while welding is going on?

A. No. That would be true.

The same holds true with Figure 2.

Q. Now, in this Robinoff Patent, if we compare that with the earlier Lincoln Patents you were talking

2065 about and had a chart on, we find the set up is a little different in that there is a groove provided by

bevels on the edges of the plates in Robinoff, but not in Lincoln; is that right?

A. That is right, in the illustrations and in the specifications.

Q. And in the Robinoff Patent, he suggests the use of a somewhat different flux, is that right?

A. He suggests the use of clay and—

Q. Will you point out to me the line in the Robinoff patent which suggests the use of clay, please.

A. No, I guess not. He refers to it as the flux, I think.

Q. He just says "a flux," doesn't he?

A. "Flux material."

Q. He does say, however, on page 1, first column, beginning at line 40:

"The groove is then filled with a powdered flux composition having a percentage of ground or powdered scale (ferrous oxide) to make the flux magnetizable."

What percentage of ferrous oxide do you have to have to make the flux magnetizable?

2066 A. I don't know.

Q. As a matter of fact, ferrous oxide isn't magnetizable in the molten state or at any temperature even close to it, is it?

A. That is correct.

Q. Well, now, aside from these two points that we have spoken of, that is, providing a groove in which to confine the flux and putting in enough ferrous oxide to make the flux magnetizable, what else is there that Robinoff teaches in his patent that you don't find in the Lincoln patent?

A. Well, I should say that the feature that he calls the fundamental feature—

The Court: Who?

The Witness: Robinoff,—is the maintaining of a relatively heavy coating of flux or slag on top of the molten metal, to permit all gases to escape from the molten metal, was what Robinoff featured in his patent.

2067 Q. That, in your opinion, is the principal feature?

A. I think so, yes.

2068 Mr. Wolfe: The letter to which I had reference, Mr. Yeomans, is Plaintiff's Exhibit 222 (handing document to witness).

Mr. Stewart: May I ask what the question is, your Honor?

Mr. Wolfe: I am asking him if he is acquainted with this letter.

The Witness: I have read the letter now.

By Mr. Wolfe:

Q. You had not seen it before?

A. I never saw it before.

Q. Have you ever attempted to make any welds using a flux composed of clay, lime and ferromanganese?

A. Yes, sir.

Q. Have you ever tried to make any welds using
2069 a flux composed of clay and iron scale?

A. I think so. I have seen them.

Q. Was that done at the Lincoln laboratory when you were there?

A. That was, I believe.

Q. In that instance when you observed those tests did you observe whether or not there was a continuous layer or blanket of slag over all molten metal in the weld?

A. Yes. After the weld is completed there is a layer of molten slag, solidified on the weld.

Q. Yes, but while the welding operation was going on did you make any observation as to whether or not there was such complete coverage over all molten metal while the weld was being made?

A. I would not be able to see that.

Q. In the course of Mr. Byron's opening to the Court it appears at page 61 of the record that he said:

"An earlier patent to Robinoff showed the entire process which the plaintiff is now trying to tell your Honor we infringed."

I would like to know, Mr. Yeomans, whether or not you agree with that statement.

2070 A. Yes, sir.

Q. You mean by that, that in your opinion the Robinoff patent discloses everything that is taught in the patent in suit, or discloses everything that the Lincoln people are doing, or do you make any distinction?

A. No. Relative to the process of welding. The Robinoff process, I think, discloses everything relative to the process of welding that was disclosed in the original application as filed of the patent in suit, and also discloses everything that I think is practiced by Lincoln and in the demonstration I have seen at the Linde mill.

Q. Now, let us look at your chart here again, Exhibit 140, of the Robinson process patent. In that upper right-hand figure there, that shows a section cut through a pair of plates that have their edges beveled and are pushed together to form a Vee in which you are going to make the weld, is that right?

A. Yes. This is diagrammatic, and these drawings are like every other Patent Office drawing of this kind.

Q. Those plates in that case might be, say, five-
2071 sixteenths of an inch thick? That was the thickness Mr. Robinoff said he had welded, was it not?

A. I think he did.

Q. And the bevel there is such as to give a feather edge with no nose there?

A. That is right. That is, in this drawing.

Q. And that is the same sort of edge preparation, if you recall, that was used on the plates in the plaintiff's demonstration No. 5 where we used a clay flux; do you remember that?

A. Yes. That is the first time I had ever seen that done.

Q. If you took a pair of such plates five-sixteenths of an inch thick and beveled them to a feather edge like that and just filled the groove just flush with the top of the plate with Lincolnweld 660 flux, could you successfully weld those plates in a single pass?

A. Well, assuming this backing strip under it, and everything?

Q. Right.

A. You could probably weld it in a single pass, a five-sixteenths plate. It would depend on the current and the
2072 weld rod and also it would depend on that backing plate considerably. I see no reason why it could not be done.

Q. Well, if instead of using a feather edge you put a nose on there, say one-eighth of an inch, then would you be sure that you could do it?

A. Yes, sir.

Q. Then you would feel absolutely positive?

A. That is right.

Q. Now, I wish you would look with me at the third one of your charts, Defendants' Exhibit 141. The two figures at the top of the chart—

A. 141 is that?

Q. Yes. Those were taken from Jones patent 2,152,194?

A. That is right. They are turned around to put them in the same relative position, but otherwise they are, I believe an accurate representation.

Q. Those are more or less diagrammatic representations, are they?

A. Just like the patent drawings, yes, sir.

Q. Now, in your opinion do these drawings, having in mind the fact that they are diagrammatic, accurately represent the setup in the Lincolnweld process as you know it?

A. Yes, diagrammatically, they would represent it
2073 so that I would understand it.

Q. Well, now, let us be sure that there is not any misunderstanding about detail here.

So far as the plates to be welded are concerned, and the electrode, and the generator connected with one terminal to the plate and the other to the electrode, there is no question about that.

A. No, sir.

Q. And there is no question that a granular flux, indicated at 14, is put down along the seam to be welded?

A. Right.

Q. Now, the numeral 19 here is applied to a somewhat different style of cross-hatching in the layer of flux, and the portion of the patent which you have quoted here says:

"At successive portions of the seam, the granular material, 13, is locally fused, and becomes highly fluid, and superheated, as indicated at 19 in Figure 2."

That is, in other words, apparently intended as a representation of a liquid pool, into which the electrode is shown projecting.

Now, would you take that to be accurate?

2074 A. You do not have to. There is wording right in the patent, lines 47 to 49, column 2, page 2, of this same chart:

"* * * the welding zone, 19, comprising highly fluid welding composition and fused metal"—

That describes that.

Q. Well, now, let us take it on this basis: If we assume that 19, here, is to represent a liquid pool, and of course, the electrode, 15, is shown projecting down into that, would that be a proper representation, now, for the Lincolnweld process?

A. No, sir.

Q. At 26, the last quotation which you have here on your chart, it says:

"The lines of flow of current in the fluid welding composition and fused metal are indicated by the dotted lines, 26, and extend downward and rearward of the electrode 15."

Now, of course "fluid welding composition" can mean either vaporous or liquid, so that would apply all right for the Lincolnweld setup, would it not?

2075 A. No, no. The use of the word "fluid" is a technical expression, for air and gas. We speak of fluid pressure for air pressure, and so forth and so on; but it is not practical shop language at all.

"Fluid" to a shopman, always means liquid. It does not mean air, gas, or anything of that kind. They sometimes correct me when I say "fluid."

Q. Does my memory mistake me, that when we were talking about the Lincoln patent a while ago, you told me that the gas mentioned there was fluid?

A. Technically, yes, sir.

Q. But now you are being a shopman, rather than a technician?

A. I am interpreting this patent as one who is skilled in the art.

Mr. Wolfe: That is all.

2077 *Redirect Examination by Mr. Oberlin.*

Q. In the drawing in the Robinoff chart and the drawing in the Robinoff Patent, on which you said it was based, the showing is entirely diagrammatic, isn't that correct?

A. Yes.

Q. In the case of the Robinoff patent, especially in the modified form of the process which is stated to be indicated in Fig. 3, and which you indicated is reproduced in the figures on the Robinoff chart, how is the flux applied to the work pieces?

A. It is spread along the seam on top of the work.

Q. And to what extent does the electrode or weld rod extend into that flux layer, according to the description of the patent?

A. It projects under it entirely.

Q. In that respect, is there any difference between the Robinoff process and the Lincolnweld process?

A. No, sir.

Q. Is there any difference between the Robinoff process and the Unionmelt process, as exemplified by these demonstrations?

A. No, sir.

Q. In the case of the Robinoff patent as described
2078 —the Robinoff process as described in the patent and as illustrated in this chart, what is stated or what do you understand exists between the lower end of the electrode and the work piece?

A. Well,—

Q. (Continued) What does the patent state in that regard?

A. It says:

"After the groove has been filled with flux the welding head of the welding machine, having a reel of welding rod or electrode wire thereon, is started in operation to feed the electrode down into welding position with respect to the flux filled groove and also to feed the electrode longitudinally of the groove. After the electrode is brought into proper position an arc will be struck so as to melt the flux in the groove and also to melt the metal of the electrode so as to furnish a deposit of metal in the groove."

Q. In the light of that description, what do you understand exists between the end of the electrode as designated in this Robinoff chart, and the work piece?

2079 A. Well, an arc stream, and nothing else.

Q. Will you refer to the Jones patent No. 2,152,194, as illustrated in the corresponding chart, Mr. Yeomans, and state what, in your understanding from the description of the patent, exists between the end of the electrode there and the work piece.

A. Well, the patent says that there is a conductive melt exists there, and the representation is the same as in the Robinoff patent; and certainly I don't know how any welding could be done.

Q. I am not asking that question. I am asking what the patent states exists between the end of the electrode and the work piece.

Mr. Cahill: I move to strike out the witness' last statement as not responsive to any question.

The Court: Motion allowed.

Mr. Oberlin: Proceed.

The Witness: It says:

"The flow of current between the electrode and the work heats a region of the welding composition 13 so that it fuses and becomes a high resistance conductive path, 2080 and this region of fused or liquid material supplies heat to fuse the end of the electrode 15 and the edges of the plates 11 and 12."

By Mr. Oberlin:

Q. Is there any reference there to an arc—

A. No, sir.

Q. —being involved in the heating operation?

A. No, sir.

Q. Is that in accord with your understanding of the teachings of the patent in suit?

A. That is correct.

Mr. Oberlin: That is all.

Recross-Examination by Mr. Wolfe.

Q. Just a question or two, Mr. Yeomans.

On this chart, Exhibit 141, of yours, that Mr. Oberlin was asking you about, would it, in your opinion, be possible to have an arc down there at 26 at the bottom of the pool of liquid, if 19 be taken to the pool of liquid?

The Witness: Will you read the question, please.

(Question read.)

2081 The Witness: Why, yes, I think that there would be an arc there always. I don't think there is any pool of any form under the arc.

By Mr. Wolfe:

Q. That is what I wanted to get at here. Is it, in your opinion, possible to have an arc down underneath, inside of a pool of liquid flux?

A. Why, yes, if the pool is big enough.

Q. And is it possible to get a pool big enough for that purpose, in an ordinary welding operation, in an arc weld like this shown here?

A. Yes, I think so. I think it would be possible to have an arc and a pool entirely surrounding it.

Q. You do not find any difficulty in reconciling that in your mind?

A. No. An arc with a pool of molten flux surrounding it I think is perfectly possible.

Mr. Wolfe: All right.
Mr. Oberlin: Are you through?
Mr. Wolfe: Yes.

Redirect Examination by Mr. Oberlin.

Q. Is that the manner in which the operation of
2082 the Jones patent in suit is described, in this second Jones patent as shown in the chart, Exhibit 141?
A. No, sir.

Q. Will you read the appropriate portion of the description either from the chart or from the patent which describes how the welding is accomplished in this Jones process or Jones et al process? I refer to the second paragraph of the chart.

A. I read that a moment ago, I believe:

"In order to complete the welding circuit to start a welding operation, suitable material, such as steel wool, is provided to bridge the gap between the end of the electrode 15 and the plates 11 and 12. The flow of current between the electrode and the work heats a region of the welding composition 13 so that it fuses and becomes a high resistance conductive path, and this region of fused or liquid material supplies heat to fuse the end of the electrode 15 and the edges of the plates 11 and 12. The molten
2083 metal deposited from the electrode coalesces with the fused edges of the plates, and the fused material and molten metal occupy the entire space forming the welding zone."

Q. Is such mode of operation consistent with the existence of an arc at the point concerning which counsel inquired?

A. There could be no arc if the fused material and molten metal occupy the entire space forming the welding zone.

Mr. Oberlin: That is all.
Mr. Wolfe: No further questions.
(Witness excused.)

The Court: We will take a short recess at this time. Before we do, I would like to say this: I have given consideration to the question having to do with certain exhibits. I do not have them in mind, but they are the ones on which I reserved ruling.

Mr. Oberlin: Those were in connection with Mr.
2084 Robinoff's testimony. Mr. Stewart will address himself to those.

The Court: It seems to me, as to those exhibits which have to do with Mr. Robinoff's statements made and contained in these letters previous to the time of this application for an invention, that the only time they would be material would be on a question of conception, if that question were in issue in this case.

I am not saying that they would be admissible even under those circumstances, but it seems to me that that would be the only reasonable ground for their admission, because of their self-serving nature. It seems to me that as to when he conceived it—and not ruling as to what conception he had—is not in issue here because of the fact that the Robinoff patent preceded in date the patent in suit. Therefore, these documents are inadmissible in evidence because of their self-serving nature.

The other documents having to do with the chemistry analysis do not, it seems to me, meet the standards set forth in Title 28, Section 695, of the Code, and do not come within that category of business entries kept
2085 in the regular course of business with which that statute deals; and for the reasons set forth in the decision in *Palmer* v. *Hoffman* the objections are sustained as to those exhibits.

2086 Mr. Stewart: If the Court please, there is one question about the exhibits upon which ruling was reserved.

If you will recall one series consisted of a letter from Mr. Robinoff to Mr. Reuff and an enclosure in that letter; also there was a chart or drawing by Mr. Robinoff.

My own recollection is the drawing was admitted.

The Court: I think that is right.

Mr. Fowler: That is my recollection, too.

Mr. Stewart: I want to make that certain. That was my recollection, although the transcript does not show that.

Mr. Fowler: I have no objection to that.

The Court: That particular exhibit is admitted. The record may so show.

Mr. Stewart: The drawing was Defendants' Exhibit 108.

(Whereupon said drawing marked DEFENDANTS' EXHIBIT 108 was admitted in evidence.)

2087 Mr. Stewart: The letters, Defendants' Exhibits 109 and 110 have not been admitted; and 118, I believe, was the other.

We have one other matter, your Honor. I have here a number of sections of two plates of steel that have been welded together on the upper edge. They relate to the testimony of Dr. Nusbaum, who took, you will recall, the X-ray pictures.

These are the pieces of steel and the welds on top of each that were made when the X-rays were taken.

I have taken this up with plaintiff's counsel. Dr. Nusbaum, if he were here, would testify that these sections of plate were marked with the same Roman numerals that the X-ray plates bear; they were cut under his supervision, and he would identify them as the identical welds made during the taking of the X-rays.

I have discussed that with plaintiff's counsel and we would like to offer them as exhibits.

Mr. Wolfe: No objection.

2088 The Court: They may be admitted.

Mr. Stewart: They will be offered as—the one to be marked as Defendants' Exhibit 151 bears the Roman numeral I, and is to be related to the X-ray film, Defendants' Exhibit 121-A.

The one to be marked Defendants' Exhibit 152 bears the Roman numeral II and relates to the X-ray film, Defendants' Exhibit 121-B.

The one to be marked Defendants' Exhibit 153 bears the Roman numeral III and relates to the X-ray film bearing Defendants' Exhibit No. 121-C.

The one to be marked Defendants' Exhibit 154 bears the Roman numeral III-2, and relates to X-ray film in evidence as Defendants' Exhibit 121-D.

The one to be marked Defendants' Exhibit 155 bears the Roman numeral IV-2, and relates to X-ray film Defendants' Exhibit 121-E.

The one to be marked Defendants' Exhibit 158 bears the Roman numeral VI, and relates to the X-ray film Defendants' Exhibit 121-F.

The one to be marked Defendants' Exhibit 157
2089 bears the Roman numeral VII-2, and relates to X-ray film Defendants' Exhibit 121-G.

(Whereupon the said X-ray films marked DEFENDANTS' EXHIBITS 151 to 157, respectively, and were admitted in evidence.)

Mr. Stewart: I have also offered, your Honor, to produce—we don't have them here, but I can get them from Cleveland—the identical welds made during the time that Dr. Nusbaum took the X-rays where clay flux was used, which was brought out on cross examination, if you want them. Whether you want them or not,—

Mr. Wolfe: I would like to see them.

Mr. Stewart: I will bring them. I offer these in evidence.

The Court: These exhibits may be admitted.

2090 Mr. Oberlin: In that connection, may it please the Court, I would like to offer now, if they have not already been offered, Defendants' Exhibit No. 138, that being the compilation of specifications which was used during the direct examination of Mr. Yeomans; and likewise Defendants' Exhibits Nos. 139, 140 and 141, being respectively the charts illustrative of patents 1,589,017, 1,782,316 and 2,152,149.

Mr. Wolfe: No objection.

The Court: Admitted.

(Whereupon the said charts marked DEFENDANTS' EXHIBITS 139 and 140 were admitted in evidence.)

Mr. Oberlin: Also the article entitled "New Pipe Mills at McKeesport Works of National Tube Company," Defendants' Exhibit 148.

Mr. Cahill: To that exhibit we objected, may it please the Court, and the objection was sustained, if I recall correctly.

Mr. Oberlin: No, that is not correct. The exhibit was merely identified before.

2091 Mr. Cahill: It was merely identified, you say?

Mr. Oberlin: Yes. There was some testimony regarding it. It was an exhibit in plaintiff's own deposition, taken in Cleveland.

Mr. Cahill: Let me see it, please.

Mr. Oberlin: (Continuing) On the direct examination I think of Mr. Lincoln, last January. It is a published article, pleaded in the defendants' answer as a prior publication.

Mr. Cahill: We have no objection to its going in merely as a publication. The hearsay part of the article, however, was never cleared up, so that it does not speak for the truth of the matter therein contained.

Mr. Oberlin: The Court ruled adversely, as to any testimony in that connection on the part of the witness.

Mr. Cahill: Then it goes in purely as a prior publication, I take it.

The Court: Well, I do not know whether there is
2092 any restriction on the purpose for which it is to go in.

Mr. Cahill: The fact that it was published is admitted, but as to the truth of the statements therein contained, they are entirely hearsay.

The Court: Well, that is a matter of interpretation, is it not?

Mr. Cahill: No, your Honor. There has been no proof offered as to the truth of those statements. This witness was not there at the time this alleged work took place.

Mr. Oberlin: Well, that would likewise be true of the patents. Nobody was present at that time.

The Court: It is admitted.

(Whereupon the said document marked DEFENDANTS' EXHIBIT 148 was admitted in evidence.)

Mr. Oberlin: And finally, I offer in evidence Defendants' Exhibits 149 and 150, 149 being the container containing the so-called Miller flux, and 150 being the plate, with the weld.

2093 I believe that this offer was ruled upon, and that these exhibits have both been admitted, although they have not been so marked.

Mr. Cahill: They were admitted with a restriction, if I recall correctly.

Mr. Oberlin: The restriction was that the bead identified by the witness would be the only part of the exhibit before the Court.

The Court: I think that is what the record shows.

Mr. Oberlin: I think so.

(Whereupon the said articles marked DEFENDANTS' EXHIBITS 149 and 150 respectively were admitted in evidence.)

Mr. Oberlin: Now, with the same qualification as stated by Mr. Stewart, that if we find we have overlooked any exhibits, we may offer them in evidence, the defendants rest.

(Thereupon the defendants rested.)

2094 Whereupon the plaintiff, to further maintain the issues in its behalf, in rebuttal, introduced the following evidence:

Mr. Fowler: The plaintiff will now read in evidence a part of the deposition of George Gideon Landis, a vice president of the Lincoln Electric Company.

This deposition was taken at Cleveland, Ohio on May 13, 1946. I will go, then, to page 422:

2095 "Q. The chemical composition of the coating on your Fleetweld rod is different from the composition of your Lincolnweld 660 flux, is it not?

"A. Yes.

"Q. And the difference results from the fact that different characteristics are required for the two, does it not?

"A. I don't want to fail to answer the question, Mr. Wolfe, but I have nothing to do with the electrode department, and I am afraid I can't be too definite in any statement regarding that. I know in general. I would be glad to have the question repeated. I didn't know whether you understood that I had no responsibility in that connection.

"Q. You are not overly familiar with the practice in rod coating.

"A. No. I know nothing at all about it except what you would expect me to know being associated with the company. I will be glad to answer any questions along that line that I can. Do you care to have the question repeated?

2096 "Q. Yes.

"Mr. Wolfe: Will you read it back?

"(Question read.)

"A. I would say yes.

"Q. In your affidavit you have also said, on page 4, that 'Many hundreds of different flux combinations suitable for use in conjunction with fusion welding by means of the electric arc have been proposed and used since arc welding itself was first introduced.'

"Can any of those hundreds of fluxes be used, in your opinion, in place of the Lincolnweld 660 flux?

"A. If you mean by that to get the same results, I will have to say no.

"Q. What failing in results would appear?

"A. Primarily in the quality of the welded metal that is produced.

"Q. Now in your affidavit, again at page 4, you have said:

"'In connection with arc welding, whether using a carbon or metallic electrode, it has long been recog-

2097 nized as desirable to employ a so-called flux which is a composition of material similar in its general function to that of the flux used in ordinary soldering and braz-

ing operations, as well as in so-called 'Smith Welding' such as has been practiced from time immemorial by the Smith at his forge.'

"How is the flux commonly used in, say, a brazing operation? I mean, how physically does the user go about the process?

"A. I do some brazing myself, and I put it on either way, the paste or the powder. Usually plain borax or boric acid is used, or there are prepared fluxes.

"Q. Those are the common ones?

"A. Those would be the ones you would use if you didn't have a prepared flux.

"Q. And you put that down as a powder along the joint where you want to weld with your braze torch?

"A. A good many people do it. I usually do it myself
that way, or it is just as easy, or a little more con-
2098 venient sometimes, to use it as a solution and paste
it on with a brush.

"Q. And then what do you do? Take a torch of some kind and carry the flame along where the powder is?

"A. Feeding in a suitable brazing rod, of course, and the torch can be most any type, electric or gas.

"Q. Now, how about this Smith welding 'from time immemorial'? How does he go about that?

"A. Well, I am not too familiar with that. I have done a little bit of it, and I have seen a little of it done, a reasonable amount. They usually insist upon running the scarfed piece that they are going to weld into a block of material, which they feel will help eliminate the oxides.

"Q. What do you mean by a scarfed piece?

"A. That is a little different scarf. If you are going to weld two pieces together, they flatten one like the end of your finger, and then they flatten the other like the end
of your finger, and lay the two together in this man-
2099 ner. (Indicating.)

"Q. And then hammer them when they are—

"A. And then hammer them when they are hot.

"Q. Where do they put the flux in that case?

"A. Usually rub the piece onto—I am sorry. I don't know the name of the material that they use, but it is a block that they rub it in, and then put them together, and that small amount of flux material helps to keep the joint free from oxide.

"Q. That is rubbed on the abutting surface?

"A. Abutting surfaces. It is put on in a different manner than these others.

"Q. They don't put that on as a powder?

"A. No.

"Q. Now in this brazing operation where you say you use powdered borax, or something of that kind, you say you put that on the joints and feed in a filler rod and run
2100 the torch flame along the joint; is that right?

"A. It can be done that way, yes.

"Q. And in this J. C. Lincoln patent, that is also discussed in your affidavit, No. 1,589,017, there the patentee also suggests the use of borax, and, from the description, I take it he would put the powdered borax along the joint with the filled rod like you do in brazing, only running an electric arc flame along it instead of a torch flame; is that right?

2101 "A. He could do it that way.

"Q. That is the general arrangement that is described in that patent, as a matter of fact, isn't it?

"Mr. Oberlin: The patent speaks for itself. If the witness is to be questioned about it, it should be produced.

"Q. In your affidavit on page 5 you have said: 'As illustrated in the figures of the John C. Lincoln patent just referred to,'—No. 1,589,017—'the electrode h is not necessarily brought into contact with the layer e of flux nor does it have its lower end submerged in such layer.' Now, what I wanted to know about was that phrase 'not necessarily.' In the Lincoln patent the electrode is shown rather clearly as not submerged, isn't it?

"Mr. Oberlin: Have you a copy of the patent to confront the witness with?

"Q. (Patent handed to the witness.)

"A. Now, what is your question?

"(Question read.)

"A. Your question is that the electrode—at least,
2102 your statement is that the electrode is not submerged in the flux as shown in the illustration, as I understand it.

"Q. Yes. There is no question but what it is not submerged, is there?

"A. That is correct.

"Q. Did you find anything in the description that would lead you to believe that submergence was contemplated?

"Mr. Van Duzer: I object to that question. I don't

think he need answer. The patent speaks for itself. It is in the nature of an argument.

"Q. In the process that is described in this J. C. Lincoln patent, the arc would be plainly visible at all times, would it not?

"A. Yes.

"Q. Now, there was another patent that you have discussed in your affidavit; that was patent No. 1,782,316 to Robinoff, et al., and in that patent at page 1 is the statement: 'The groove is then filled with a powdered flux
2103 composition having a percentage of ground or powdered scale (ferrous oxide) to make the flux magnetizable.' Now, so far as I have been able to find, that patent doesn't say anything above what the flux composition should be except that it ought to have ferrous oxide in it; so, speaking as of May 10, 1929, when the application for that patent was filed, what would you say would be a normal choice of flux material?

"Mr. Oberlin: Choice by whom? I object on that ground.

"Mr. Wolfe: Anyone skilled in the art who has had that teaching presented to him.

"Mr. Van Duzer: You mean what might be used?

"Mr. Wolfe: What would be the normal expectation of the art as of that date?

"Mr. Van Duzer: If you know, Mr. Landis, answer it.

"A. I am not sure I can answer your question, Mr. Wolfe.

"Q. Well, the J. C. Lincoln patent we were speaking of a moment ago says on page 3 that you may use as-
2104 bestos, sodium carbonate, or borax as a flux. Would one of those three, in your opinion, be a reasonable choice for a flux at that period? Of course, the Lincoln patent was filed a little earlier than the Robinoff.

"A. You mean for that particular purpose? Yes. That has nothing to do with the question you asked regarding the Robinoff patent.

"Q. Well, let me put it this way: Mr. Robinoff says in his patent that you should use some flux, and, so far as I can see, the only other information he gives you on that is that you ought to put some iron oxide in it, and what I am trying to get at here is what would a man at the date when Robinoff spoke have picked out for flux in this Robinoff process if somebody had said, 'Go out and get a bucket of flux.' Now, can you give us any information on that?

"Mr. Van Duzer: That is pretty conjectural, if you want a conjecture.

"A. I don't really know how to answer that.

2105 "Q. Do you know from your experience and familiarity with electric welding what were common electric welding fluxes in 1929?

"A. I have no information outside of what I read now. I was not connected with it at that time.

"Q. Well, what do your researches in the literature tell you on that subject?

"A. Well, it is rather confusing. I have read about most everything being used as flux. We have used steam and various kinds of slags and clays, and almost anything. It was fairly common knowledge that rusty wire welded better than clean wire, if you want to go back that far. I would gladly answer any question I can, but I don't think the question is definite enough for me to give you any kind of an answer on it. One person would go one place, and one would go another. I don't know what I would do if I wanted to get a flux back in 1929.

"Q. You don't think on the basis of that that there is any definite answer to what somebody would have

2106 used as flux in 1929, if they were simply told to get some flux and put some iron oxide in it?

"A. Well, each person would undoubtedly have his own ideas of what the answer to that question would be."

2107 Mr. Cahill: We have a couple of reels of movies that were admitted towards the close of one of the sessions of the direct case and have not been shown to the Court. We have the projector here and we would like to show those at this time, if agreeable.

The Court: Any objection?

Mr. Oberlin: What do they show?

Mr. Cahill: I will give you the numbers. They were marked in evidence.

Mr. Oberlin: What are they?

Mr. Cahill: The commercial use.

Mr. Stewart: Sun Shipbuilding?

Mr. Fowler: They were introduced in Mr. Cornwell's examination.

2108 Mr. Cahill: Will you set up the machine?

(And thereupon the projector was set up and the showing of the film, Plaintiff's Exhibit No. 213 was shown without comment.)

2110 HOBART HURD WILLARD, recalled as a witness on behalf of the Plaintiff in rebuttal, having been
2111 previously duly sworn, was examined and testified as follows:

Direct Examination by Mr. Wolfe.

Q. I would like to call your attention, Dr. Willard, to certain testimony of Dr. Booth given on his redirect examination, which appears at page 1828 of the stenographic transcript of this proceeding.

He was asked the question:

"Q. Now, Dr. Booth, have you during the noon recess calculated the relation or proportion of the base ingredient in the Lincoln 660 flux, to the acid, or the silica?"

And his answer was:

"A. Yes, sir."

Then the next question was:

"Q. And what did you find it to be, accurately calculated?"

And his answer was:

"I used the analysis that was submitted by Dr. Willard, and found that the ratio of the acid constituents to the base constituents was in the ratio of 67 to 78, approximately.

That is not the stoichiometric ratio. There are
2112 eleven points of base over the acid ratio, or amount.

"In other words, it is a basic flux."

Now, I want to ask you several questions about that, Dr. Willard.

2113 First of all, have you checked the correctness of the figures for total equivalents of bases of acid constituents of the Lincoln flux, as calculated from your analysis?

A. Yes, I have. I found a somewhat different result than was reported by Dr. Booth. I found it to be for the basic constituents, .75 and for the acid constituents .67.

Q. In determining the stoichiometric ratio, is it a matter of subtractions, such as Dr. Booth evidently used here, or a matter of division?

A. In determining the ratio, you must use a process of division.

Q. And what is the ratio, first of all, using his figures?

A. His figures give the ratio, basic constituent to acid, 1.16 to 1.

Q. And what is the ratio, giving the figures you used a minute ago?

A. 1.11 to 1.

Q. In connection with that matter, I also want to direct your attention to a line or two in the patent in suit.

On page, in the second column, beginning at line 2114. 10, the patent says:

"For example, if the basic constituent is lime, the proportions by weight will be approximately 0.7 to 1 part of CaO to 1 part of SiO_2; * * *"

Now, if you translate those weight proportions into molecular weight proportions, what have you as the permissible basicity?

A. I find that if one takes the upper limit of one part CaO to one part SiO_2, the ratio is such that there is a notable excess of the base over acid constituents.

Q. Turning to another matter, Dr. Willard, at page 1809 of the record it appears that Dr. Booth testified that in his opinion any resemblances between manganese and calcium is entirely superficial.

Do you agree with that opinion?

A. No, I cannot agree with that opinion. Both of these elements have bivalent oxides which are basic, and these oxides are universally recognized as interchangeable bases in forming silicates.

Q. And still a further point, this time in Mr. Yeoman's testimony. At page 2000 in the transcript he was testifying in reference to the Miller patent No. 1,741,031; and 2115 it appears that he testified that, in his opinion, boro silicate glass was a metallic silicate.

What is the fact on that matter?

A. There are two distinct classes of compounds. In the borates, the acidic element is boric acid. In the silicates, the silicate acid is silica or silicic acid.

Then there is a third group which is known as the boro silicate. And in these compounds, both the boric acid or boric oxide and silica are present to form the acid constituents of the compound. So that here we have two acid constituents, instead of one, as in the case of silicates.

Q. So you would say that a boro silicate glass is not correctly designated as a metallic silicate, for those reasons?

A. Yes. I would say it is a different type of compound.

Mr. Wolfe: You may cross-examine.

Cross-Examination by Mr. Oberlin.

Q. What about the fluosilicate, Doctor?

A. Fluosilicate is still different, because it has no oxygen in it at all.

2116 Q. So the fluosilicate would not come in the category of silicate compounds, in your estimation?

A. In name it does; in composition it does not.

Q. Would that be true of a fluoxysilicate?

A. I don't know. I don't know anything about that type of compound. I heard it mentioned for the first time the other day. I don't know.

Q. In other words, if Defendants' 660 composition is a fluosilicate, it would not come in the composition of a silicate?

A. Oh, yes, because fluoride is the minor constituent—

Q. You still don't call it a fluosilicate, according to your terminology?

A. There is no oxygen in fluosilicate.

Q. There is not?

A. No. Fluosilicate has a radical SiF_6, and no oxygen.

2117 Q. What has become of the SiO_2 component?

A. Well, there is not any in there.

Q. That is your position?

A. Well, there is no question about it. The formula is SiF_6 for that radical. It is not a question of position. It is just a case of looking at the formula.

Q. Now, with regard to boro silicate glass there is a metal constituent in that, is there not?

A. Yes.

Q. What is the metal?

A. It could be sodium boro silicate, for example.

Q. Well, if you fuse borax and silica together what is the metal element?

A. It would be sodium in that case, if you use borax.

Q. Because you are using borax and that is sodium borate?

A. That is right.

Q. And when, as in the Miller patent of record, you fuse borax and silica together, you then have sodium boro silicate, is that correct?

A. I think you could form one that way, yes.

Q. Well, that is what the patent teaches you obtain, is it not? Is that correct?

2118 A. Yes. I think you can. It says you can use some borax.

Q. And that is what is called a boro silicate glass in the patent?

A. Yes. I think you would call that combination a boro silicate glass if you had the right proportions.

Q. Now, referring to your recalculation of the base constituent and acid constituent, do you say that those are present in the compound in question in what is called stoichiometric proportion?

A. Well, if you mean the exact proportion to form a metasilicate, no, they are not, because in this portion of the patent which was just read it says here on page 2, Column 2, line 10:

"For example, if the basic constituent is lime, the proportions by weight will be approximately 0.7 to 1 part of CaO to 1 part of SiO_2."

So there is a certain variation permissible there, and of course if you have exact stoichiometric proportions of calcium to silica, that would be a very definite thing, but the patent permits you to vary from the stoichio-

2119 metric proportion of base to silica.

Q. How much may you vary according to the patent? How definite is it in that regard?

A. Seven tenths to one part of calcium oxide to one part of silica.

Q. Well, you say that you can vary from the stoichiometric proportions according to the teaching of the patent. I am asking you now as a chemist how far may you deviate from the teaching in that respect and still be within the patent teaching?

A. What do you mean when you say "how far"? In what units do you want me to express it?

Q. Any you choose. Take percentage or otherwise Is the patent specific on that point? That is what I am really asking you, sir.

A. No. It gives you a certain leeway.

Q. Considerable leeway, does it?

A. Yes. Considerable leeway.

Q. But no definite limits?

A. Seven tenths to one is the proportion given in the patent.

Q. If there is an excess of the manganese oxide in the 660 compound, that will act as a reducing agent, is that correct?

2120 A. Well, now, when you say "act as a reducing agent," in what way do you think it could act as a reducing agent? I do not know. If manganese is present in the form of the bivalent oxide, I do not see how you can do anything more than to allow it to take up oxygen from the air.

Q. From any available source?

A. No, not from any available source, but from the air.

Q. Well, we went over that completely, I think, in our cross examination in Plaintiff's prima facie proofs. There is an excess of manganese oxide in this 660 compound?

A. Yes.

Mr. Oberlin: That is all.

Mr. Wolfe: No further questions.

(Witness excused.)

Mr. Wolfe: Take the stand, please, Dr. Doan.

GILBERT E. DOAN, recalled as a witness on behalf of the Plaintiff in rebuttal, having been previously duly sworn, was examined and testified as follows:

2121 *Direct Examination by Mr. Wolfe.*

Q. Dr. Doan, I would first of all like to call your attention to certain portions of the testimony of Mr. Yeomans. It appears at page 1950 of the stenographic record that, in discussing the three applications which were successively filed, and finally matured in the patent in suit, Mr. Yeomans said, at that point, that in his opinion the method of welding taught by or disclosed in the second application, was entirely different from that of the first. Then at page 2049 I asked him on cross examination if he was referring simply to the character of the description in the second application, when it was filed, and he indicated that his opinion would be the same for the application throughout its pendency.

Then finally, he testified at page 1953 that in his opinion the final application was the same as the second one,—that is, the third or final one was the same as the second one.

Now I want to put several questions to you along that line, Doctor.

2122 Q. Now the first point, Dr. Doan, is this: What in your opinion is a correct comparison of the methods disclosed in the first application of the series, and in the second application, as the latter was filed?

A. In the first application, the process was designated as arc welding.

In the second application, the inventors say:

2123 "The resistance is provided, not by a body of ionized gas, but by a conductive melt."

They say, furthermore, in the second application:

"Several circumstances show clearly that our process does not depend on the formation of an arc."

Q. Well now, did you find what you consider to be any significant amendment or change in the second application after it had been filed?

A. Yes, sir, I did. The amendment is written in, or the phrase is changed there, to say:

"Several circumstances show that our process does not depend upon the formation of an arc of the usual type."

Q. And then finally—

A. (Continuing.) These differences are differences in their explanation of the theory of the process.

The process itself, however, was the same.

Q. Well now, finally, in the third or last application of the series, how does that compare with the second one, as amended, on the matter of this arc theory?

2124 A. It is the same.

Q. Well what, then, does the final application, and the patent issued thereon, teach, with respect to the fundamentals of the process disclosed?

2126 A. It teaches a number of things with respect to the fundamentals.

I would mention first of all that the current is conducted through a pool of conductive melt, and that the rod is immersed in this pool of conductive melt.

By Mr. Wolfe:

Q. Well, will you outline just briefly, Dr. Doan, the results that follow from that matter of immersion?

A. When we saw the demonstrations of hand welding, I think we all noticed that the welder bent over and spent a great deal of time and paid a good deal of attention in keeping the arc length correct.

If he had not done that, the metal would be contaminated by the air, and its properties injured.

In the present process, the end of the electrode is immersed in the pool, and therefore it is sealed against
2127 all excess of air to contaminate the metal.

As a result of the sealing, current values higher than have ever been thought possible before, can be sent through the pool, and the spectacular speeds are obtained, for that reason.

The welder would ordinarily feel that he was robbed of all control, when he could no longer watch the end of the electrode; but in this process, the welding operation itself is fully automatic, and that watching is no longer necessary.

These high currents produce a large pool of molten metal, and the necessity of seeing that he melts this edge, and that edge, and that the metal piles up behind in the proper form, has been completely removed.

The process is, therefore, completely automatic, not only as to the feeding of the rod, but as to what goes on under the pool of flux, where he cannot see it.

Q. Now, Doctor, I have here your chart, which has been previously introduced in evidence and marked as Plaintiff's Exhibit No. 167.

2128 The pool of fused material to which you were referring, is, I take it, the part that is so marked on this chart; is that correct?

A. Yes, sir.

Q. And the pool of fused steel is what has been marked "fused steel" on the chart, is it?

A. Yes, sir.

Q. Now, Dr. Doan, at page 2081 of the stenographic record in this proceeding, Mr. Yeomans testified that, in his opinion, it was quite possible for an arc to exist at the bottom, or within the pool of fused flux.

Do you agree with that?

A. I do.

2129 Q. To go back for a moment to your previous testimony in this case, Dr. Doan, you did, I believe, testify that in your opinion this should properly be called an arc in the pool, is that right?

A. That is right.

Q. Does that alter in any way the description of the operation which you gave here a few moments ago?

A. No.

2130 Q. I will ask you to make this assumption, that this low density area in the center of the pool is not

an arc. Then does that alter in any way the operation that you described?

A. Not at all.

By Mr. Wolfe:

Q. What material would be added or subtracted from that pool of fused melt depending upon whether or not
2131 the low density region in it is an arc of some kind?

A. Nothing.

2133 Q. I call your attention, Dr. Doan, to Mr. Yeomans' testimony. At page 2038 of the record, the question was asked:

"Have you made any independent investigation of this matter of whether or not there is in the Lincolnweld process contact between the electrode or wire and the pool of fused flux?"

His answer was:

"I know there is not.

"Q. You just know that?

"A. There cannot be."

I put the question to you, Dr. Doan, is there, in the Lincolnweld process, contact between the electrode and the pool of fused flux?

A. There is.

Q. Mr. Yeomans was further questioned on that point, at page 2039:

"So you did not make any experiments as to that?

"A. No, sir.

"Q. You did not, for example, take any high speed
2134 motion pictures to satisfy yourself on that?

"A. No, sir.

"Q. You did not try using hollow electrodes with either suction or pressure applied?

"A. I did not try any means to determine that."

I ask you, Dr. Doan, how many tests have you made on that point?

The Witness: We tested that point very thoroughly with a large number of tests running over a period of six months or more.

2135 Q. I show you, Dr. Doan, Defendants' Exhibit 141, which is a chart that Mr. Yeomans prepared from Jones Patent No. 2,152,194. You have examined the illustrations of that, have you?

A. Yes, I have.

Q. At page 2074 of the record, Mr. Yeomans was asked this question, in reference to that patent:

"Well, now, let us take it on this basis: If we assume that 19, here, is to represent a liquid pool, and of course, the electrode, 15, is shown projecting down into that, would that be a proper representation, now, for the Lincolnweld process?"

And his answer was, "No, sir."

2136 Do you agree with that?

A. I think it is a proper representation.

Q. And he was further asked, in reference to the last question that appears on that chart of his, this question:

"At 26, the last quotation which you have here on your chart, it says:

" 'The lines of flow of current in the fluid welding composition and fused metal are indicated by the dotted lines, 26, and extend downward and rearward of the electrode 15.' "

Assuming that to be an illustration of the Lincolnweld process, as you say it properly is, would that be a proper description of it?

Mr. Oberlin: What page is that, Mr. Wolfe?

Mr. Wolfe: 2074.

The Witness: It would.

By Mr. Wolfe:

Q. At page 1262 in the transcript, Mr. Lincoln was being examined, on direct examination, and reference was made to the Lincolnweld Catalogue, Plaintiff's Exhibit 203, referred to in this question as being entitled

2137 "Lincolnweld—The New Automatic Shielded Arc Welding Process."

He was asked this question:

"Is there, as a matter of fact, any difference in the manner or the results of the fusing obtained in this 'New Automatic Shielded Arc Welding Process' from those obtained in the processes you have described where the coating has been applied—the flux has been applied in the form of a coating on the rod?"

And his answer was:

"Commercially none; technically, there might be slight variations."

Do you agree with that answer?

A. No. The differences are basic and fundamental.

2138 Q. In the course of Dr. Nusbaum's testimony, at page 1656 of the record he testified—I will read the preceding question:

"Now, Doctor, when you come to automatic welding with the bare electrode under a deep layer of flux, what happens when the electrode is fed down and touches the plate, the potential being on and the current being on, just the same as in the hand electrode? What takes place?

"A. The mechanism of the process is exactly similar."

Then again, on the same point, on cross-examination, on page 1708, Dr. Nusbaum was put the question:

"Q. You expressed certain opinions this morning, did you not, as to the similarity or identity of the electrical phenomena which take place in ordinary open arc welding, and in the Lincolnweld process."

And his answer was:

"A. It is not a similarity of phenomena, but it is an identity in phenomena."

Do you agree with those opinions?

2139 A. No.

Q. On redirect examination on page 1710 he was put the question:

"And, Doctor, when you stated your opinion about the identity of the phenomena of the open arc and the arc under a deep bed of flux, you said it was not based on observation, what was it based on? In other words—

"A. My knowledge of what is generally taught, or what is always taught in regard to the transfer of electricity in an arc, general scientific information.

Now, in your opinion does his characterization of these phenomena as being identical phenomena accord with general scientific information?

A. No, it does not.

Q. What is your opinion of the lack of identity of phenomenon based on?

A. It is based on centralized interest in the field of arc welding research by myself and colleagues and a good many graduate students over a period of more than fifteen years.

Q. Well, except on the basis of such a difference in

2140 basic phenomena, is there any way that you can account for the disparity in welding capabilities between the process of the patent in suit and open arc welding?

A. There is no other way compatible with the facts.

By Mr. Wolfe:

Q. At pages 2071 and 2072 in Mr. Yeomans' cross-examination he was asked a series of questions about
2141 the possibility of welding with Lincoln 660 flux under certain conditions. I would like to call your attention to those questions. The first one is:

"Q. If you took a pair of such plates five-sixteenths of an inch thick and beveled them to a feather edge like that"—reference had been made to the Robinoff patent and its illustration—"and just filled the groove just flush with the top of the plate with Lincolnweld 660 flux, could you successfully weld those plates in a single pass?

"A. Well, assuming this backing strip under it, and everything?

"Q. Right.

"A. You could probably weld it in a single pass, a five-sixteenths plate. It would depend on the current and the weld rod and also it would depend on that backing plate considerably. I see no reason why it could not be done.

"Q. Well, if instead of using a feather edge you put a nose on there, say one-eighth of an inch, then would
2142 you be sure that you could do it?

"A. Yes, sir.

"Q. Then you would feel absolutely positive?

"A. That is right."

Now, I ask you, Dr. Doan: Is it, in fact, possible to weld plates arranged as specified in that question and with the Lincoln flux just filling the groove flush with the top of the plates?

A. No, it is not.

Q. Can you show us by one of the weld samples here in evidence what would happen under such circumstances?

A. Yes. That specimen, X-133, which was welded
2143 with a tapered burden of flux shows it.

Q. That is Plaintiff's Exhibit 169; is that the one to which you have reference?

A. Yes. That is the one.

Q. Now, what does that indicate as to what would happen, Dr. Doan?

A. It was started at this end with just enough flux to fill the groove, and then gradually tapered up thicker to the opposite end.

2144 When the layer of flux was deep enough to form a pool that would immerse the rod, then this porosity which occurred, ceased.

Q. Well, is that particular specimen there a 5/16ths inch plate, Doctor?

A. No, sir, I believe it is one-half.

Q. One-half inch?

A. Yes, sir.

Q. Have you made any similar welds or attempts at welding of larger thicknesses of plate, which would enable you to verify your statement that the same thing would happen with a 5/16ths inch plate?

A. Yes, sir, we made a great many of them in connection with the high speed motion pictures, and in other connections.

Mr. Wolfe: May we have a light box up here, please.

(A light box was set on the witness stand.)

By Mr. Wolfe:

Q. Now, Dr. Doan, have you examined the X-rays which were introduced by the Defendants here as their Exhibits 121, and 121-A to 121-G?

A. Yes, sir, I have.

2146 Q. In those X-rays, Dr. Doan, can you point out for us any showing bearing on the immersion of the rod in the fused flux?

A. Yes,—

Q. The question is, can you do so?

A. Yes, sir.

Q. Will you now do so, please, and, as you go along, if you will be sure to state which one of the X-rays you are referring to, the record will be clear.

A. Yes, sir. In Film No. 2, the difference in density between the molten flux and the granular flux—while 2147 it is not different, or greatly different, and while the conditions in this exposure were not for the purpose of revealing that difference, nevertheless, a clear line can be seen in front of the vapor pocket, indicating a more dense region where the molten flux is, as contrasted with the less dense region of granular flux.

That same difference, although very hazy, can be seen back here (indicating), where the layer of molten flux lies on top of the weld.

Q. Dr. Nusbaum testified that he had not done any probing in that layer to verify the location of the top of the pool of fused flux.

Have you made any such checks in the course of your own fluoroscopic examinations?

A. Yes, sir, I have. We watched this same appearance on a fluoroscopic screen, instead of photographing it on a film, so that we could see continuously the advance of the rod, the vapor core, and, very faintly the layer of fused flux.

We would see it particularly clearly when, due to some gas in the steel, a bubble formed, because the bubble would reveal the film, or skin, of the fused welding composition.

2148 Q. About what is the thickness of the layer of the unfused granular flux behind the electrode there, Doctor?

A. Well, it is the thickness from here (indicating) over to here (indicating).

Q. How far?

A. Approximately one inch.

Q. And what is the approximate thickness of the layer of fused flux over the deposited metal there?

A. Oh, if this is a 5/32nds electrode, which I believe it is, and if the scattering has not distorted that width, the thickness of the fused flux was about 3/16ths of an inch.

Q. Now is there any other one of these X-rays to which you desire to call our attention, in connection with this matter?

A. Yes, sir, this one here—

Q. What is the number on that?

A. VII-2.

Q. That is VII-2?

A. Roman VII-2.

Q. Yes?

A. This is taken under conditions which show very clearly the presence of a vapor pocket, but the vapor
2149 pocket is not between the end of the rod and the weld.

The vapor pocket is up on the side of the rod, and enclosing that vapor pocket, a halo can be seen rather distinctly, indicating that the vapor pocket is enclosed in a pool of molten flux.

Q. Well, could that vapor pocket there be an arc?

A. Of course not, no, sir.

Q. Well, just to cover the point, why not, Doctor?

A. Well, because the arc would form from the end of the rod to the weld.

If it formed out here (indicating), there would be nothing for the current to flow to, since the granular flux is not conductive.

Furthermore, if this were an arc, on the sides of the rod, the end would melt off at that point.

Q. Could it stay, without melting off, through the exposure time of that film?

A. No, sir, it could not. The exposure time was
2150 only one or two seconds, which of course would be quite a long time for melting that off.

Q. Dr. Nusbaum, in his testimony at page 1625 of the stenographic record—I believe it is—testified:

"The evidence indicates that a large portion of the volume of material between the electrode and the plate is in the form of a vapor, and thus in the form of an arc."

Do you find, from your study of these X-rays of Dr. Nusbaum's, that there is in fact any large volume of vapor?

A. No, sir.

Q. What comparative work have you done yourself, in that connection, Doctor?

2151 The Witness: The simplest experiment in that respect is to weld over a hole and drain out the liquid metal that is present under the molten flux.

By Mr. Wolfe:

Q. As you explained in connection with Exhibit No. 168?

A. Yes. Now, if you measure the volume of this cabin by filling it with water, and then measure the volume of the molten metal which has run out of that cabin, you will find, after allowing for the shrinkage of the steel when it cools and after allowing something for the pool of molten flux, that there is only room left for a very tiny vapor core.

Q. I believe that the record shows that this particular weld here, Exhibit No. 168, was made at nearly 3,000 amperes.

In that instance, approximately how big was the vapor pocket?

A. Oh, about something of that size (indicating), a very small—

2152 Q. That is, the tip of your little finger?

A. Yes.

Q. Dr. Nusbaum at page 1662 of the record, was interrogated with reference to this chart of yours, Exhibit No. 167. He was asked:

"Now, what, in your opinion as a physicist, does that represent, so far as scientific possibility is concerned?"

And his particular attention was directed to this note in the upper right hand corner, in connection with conduction of electric current.

His answer was:

"It is very highly imaginative, and I do not believe—or I can state more definitely, I know that it does not represent scientific fact.

"It is misrepresentative; it misrepresents."

Now, I ask you, Dr. Doan, have you, since that testimony was given, carefully reconsidered this chart and particularly that note to which Dr. Nusbaum took umbrage?

A. Yes.

Q. Have you found any misstatement or mis-
2153 representation of scientific fact or other fact in it?

A. I have not.

Q. At page 1672 of the record, Dr. Nusbaum was interrogated as to the time that he had spent in the Lincoln Electric Company's laboratory in studying the Lincolnweld process, and the gist of it was that he had been there on two occasions, a half hour on one occasion and perhaps an hour on the second.

How much time have you spent, Dr. Doan, in studying the Lincolnweld process, the Unionmelt process and related processes, for this suit?

Mr. Stewart: I object, your Honor. I don't see how that is rebuttal.

Mr. Wolfe: Well, certainly it goes right to the point of the relative weight to be given the testimony, the conflicting testimony of these wit.esses.

The Court: Strictly speaking, though, it would be a matter that you could have developed in your main case, and it doesn't refute the defendants' witness to have him testify as to how much of his time he devoted to it, does it?

2154. Mr. Wolfe: No. But what I intend to show here is the comparative time that these men have devoted to the subject on which a conflict of opinion is now in the record, and that could certainly be an important factor in determining which is the reliable opinion.

The Court: Do you want to say anything further?

Mr. Stewart: I don't see that it has any bearing on it whatsoever. You can spend your life on it and come out with the wrong answer.

The Court: I don't believe it is a matter strictly of rebuttal, and I sustain the objection.

Mr. Wolfe: If the Court please, I would like to make an offer of proof on that, that we would show that Dr. Doan has, over a period of many months, made over 200 experiments in connection with these welding processes and has devoted weeks of time directly to their study, and has, moreover, had the help of Dr. Stout, another member of the faculty at Lehigh University.

2155 Q. Dr. Doan, in further reference to this matter of your chart, Plaintiff's Exhibit 167, and the note on it in reference to conductivity, following the portion of the record from page 1662 that I read to you a while ago where Dr. Nusbaum testified that he believed that to be a misrepresentation, he was next asked:

"Q. In what way?

"A. They speak of a pool of flux, that the entire pool is ionized, that molecules are broken up into ions and free electrons.

"As has already been stated, in a molten salt free electrons do not exist, and that is a generally and in fact universally accepted fact."

Is that a generally and in fact universally accepted fact?

A. It is not.

2156 Q. Can you refer us to any authoritative work on the subject that supports your view?

A. I can.

Q. What is it, please?

A. Here is a paper on the resistivity of vitreous materials by L. L. Holladay, physicist at the Laboratory of Applied Science, Nela Research Laboratories, communicated by the Director of the laboratory of the Franklin Institute and published in the Journal of the Franklin Institute.

Q. What is the date, and what are the pages?

A. The date is February, 1923, and the pages run from 229 to 235.

Mr. Wolfe: I now offer a copy of this paper in evidence as Plaintiff's Exhibit No. 230.

The Court: Is there any objection?

Mr. Stewart: May we see it, your Honor, before ruling is made?

The Court: Yes. Ruling reserved.

(Whereupon the said document was marked Plaintiff's Exhibit 230 for identification.)

2157 By Mr. Wolfe:

Q. Mr. Yeomans in his testimony also went into this matter of conductivity of a molten flux. I call your attention, Dr. Doan, to a portion of his testimony in that connection at page 2038 of the record.

I will begin on page 2037. He was referring to any possible current carried in the liquid portion of the pool and was asked:

"Q. In fact, I think you said it was infinitesimally small?

"A. That is right.

"Q. Well, now, if it is as small as that you would not be able to take a pair of probes with a voltmeter connected across them and measure any voltage drop between space points in that pool, would you?

"A. I would not expect to.

"Q. And you would not be able to connect one terminal of the meter to the wire and the other to a rod placed down in the pool and measure any voltage drop, would you?

"A. I would not expect to see much."

2158 I will stop there for a moment. Have you, Dr. Doan, made any such tests with a meter as those described in those questions?

A. Yes, I have.

2159 Q. What did you find?

A. If there were no contacts between the pool and the rod, it would represent an open circuit, and if you touch one terminal of a voltmeter to the rod and another terminal to the pool adjacent to the rod, you would read therefor a high voltage, the difference of potential of the rod and the potential of the flux.

If, on the contrary, the rod is immersed in the pool and contact is good between the rod and the pool, then the voltage drop between the rod and the pool adjacent would be very small. Our measurements on the average were three volts.

Q. The next question to Mr. Yeomans, at page 2038 of the record, was:

"Q. And if you did get a measurement of, say, two or

three volts that would be completely incompatible with this idea of infinitesimal current, would it not?"

His answer was:

"No. Voltage would not have anything to do with it.

"Q. A voltage drop would not be a measure or an indication of the value of current?"

2160 His answer, "No."

Is that correct?

Q. Why not?

A. Because wherever you have a current flowing, it flows because of the voltage difference between the points. The reason it flows between this point and that is because of the potential difference; and if you measure that, you can read whether or not the current is flowing.

Q. And did you make such readings?

A. Yes.

Q. Have you made any other experiments or tests to gauge the current carrying capabilities of this flux in its liquid phase?

A. Yes.

2163 Q. Will you describe that, please.

A. I started with a crucible; put a small piece of steel wool in the bottom; filled up the crucible with granular flux; and then introduced the welding wire—or rather, I mean to say, I introduced the welding wire before filling up the crucible; and gradually melted an entire crucible full of molten flux.

The electrode was kept at the top of the pool, and 2164 then immersed and fed down as it melted off.

A current of 400 amperes was carried from the wire into the pool without any evidence of an arc.

Q. Did you make any other experiments with the rod or wire in any position other than the vertical position?

A. If the wire is fed in horizontally, it has the effect of splitting the conductive pool in half, so that you can see very clearly the white-hot regions where the flux makes contact with the rod; and you can see the lines of flow which are followed by the current, as revealed by the temperature gradient through the pool of molten flux.

Q. So that you did conduct such tests, did you, Doctor?

A. Yes, sir, a number of them.

Q. Now, Dr. Doan, I want to direct your attention to the demonstrations that the defendants made out here at the Graver plant the other day, and first of all, I would like

to direct your attention to demonstration No. 3 of that schedule, which was demonstrated in their program as

"Demonstration of automatic welding under Lincoln-
2165 weld 660 flux—varying depths."

Now, with respect to that particular demonstration, Mr. Landis described the setup of the flux in his testimony at page 1742 of the stenographic record as follows:

"Q. Now, in setting up, in putting the flux on, what can you tell us as to what was done about the three different sections of the plate that were to be welded, so far as the flux depth is concerned?

"A. The first six inches was put on as the operator said he would put it on in commercial practice.

"The middle part, the next six inches, was determined by me and was arranged so it would measure half an inch, a half inch depth of flux, gauged by two parallel bars which were a half inch wide and placed on top of the plate.

"The last six inches of flux was piled on, so it was definitely more than would be used in their commercial practice."

A. Pardon me; did you say there, the next six inches, or the next two inches?

2166 Q. I believe he identified that middle length in the part that follows. He was asked the question:

"Q. Now, Mr. Landis, what were you able to observe during the progress—first, let me ask you: were any markings put on the plate itself in the way of chalk marks?

"A. I marked the area, approximately two inches long, where there was only a half inch of flux."

Now, Doctor, what did you observe with respect to the significance of that two-inch length of the half-inch deep layer of flux?

A. The length of that layer was two inches, and the length of the molten pool of metal was four inches.

Q. And what is the significance of that relation?

A. Any scars in the weld which might occur in the two-inch length, would be completely healed and eliminated in the pool, which was four inches long.

2167 Q. Now with further reference to that same demonstration, No. 3, Dr. Doan, Mr. Landis was asked at page 1743 of the record about the plate arrangement.

Q. The question was:

"Q. Was any bevelling done to these plate edges which were welded together?

"A. No preparation of any kind after the flame cutting of the plates, except the necessary tacking of the plates preparatory to welding.

"Q. By 'tacking' do you mean a hand welder was used to put on a small tack weld at each end so they would stay together, is that correct?

"A. In addition to the tabs, which are put on each end so the arc may be started and stopped off of the plate that is being welded."

What were those tabs to which Mr. Landis referred, Dr. Doan?

2168 A. Square pieces, pieces of scrap plate, on which the welding is started, and on which it is run to completion.

Q. Are they often used in Unionmelt or Lincolnweld welding?

A. Frequently.

Q. What is their function?

A. Their function is to give a continuous weld structure, and by starting the weld on a tab instead of the plate proper itself, to avoid the porosity that frequently accompanies the open arc, before the pool has had a chance to form, at the beginning.

Q. Now, Dr. Doan, I want to call your attention next to Demonstration No. 4 of that series of demonstrations by the Defendants. That was the last one of the series, and the one where they used sand as a flux.

Now have you previously run any similar attempts to weld under silica?

A. Yes, sir.

Q. And how did the resulting weld deposits compare with that which was made over here the other day at this demonstration?

2169 A. They were the same in shape and form as those that we saw over here.

Q. How did the operation compare?

A. Well, I did not use as deep a burden as the two inches or so that were used out at the demonstration here, and in my experiments it was an open arc that blew the silica away.

Q. And how did the welding action compare, in the two cases?

A. You could not see the welding action with this two-inch layer, but the welds that were formed had the same

appearance and shape as the ones which I made, using pure silica.

Q. What caused that high, narrow cockscomb form of weld deposit?

A. Silica has a very high melting point, with the result that the arc which forms in silica cannot melt enough material adjacent to it to form a pool, and therefore you have almost no conduction of electricity through the pool parallel with the arc. It is a simple arc-welding proposition.

Then furthermore, the inability of the silica to melt means that you have refractory sides of the silica—that means, difficult to melt—which hold the metal up in a high, narrow position.

2170 The failure to form a pool gives the rough effect, because it cannot smooth out into a normal liquid surface.

An additional factor is, again, the high melting point of the silica, which freezes long before the steel does, and aids in forming these surface irregularities.

2172 Q. Do you find any relation, Doctor, of these matters that you observed in connection with that demonstration to the statement on page 4 of the patent reading:

"By a proper selection of welding composition, as explained hereinabove, the energy density on the parts to be welded may be satisfactorily controlled and the production of a sound weld may be assured."

A. That is confirmation of that viewpoint.

Q. I would like to turn with you to some items in Mr. Robinoff's testimony, page 1432 of the record.

Mr. Robinoff on page 1431 had been asked the question:

"What happened to the clay after that?"

And at page 1432 he testified:

"We introduced later on a separate heating device, which was a little drum, heated, where we placed our mixture, the complete mixture, from the tumbling barrel, and heated it again, to the extent as it appeared to

2173 me, that it entered solid into the kiln, and came out, as it appeared to me, just visually, fluid-like, because it always moved in a pan.

"Q. By 'fluid', Mr. Robinoff, you don't mean in a molten state, not melted?

"A. No, it wasn't molten, sort of water-like. It seeks

its own level in a pan, and from there it was placed in little buggies, carried along the corridor, or rather a platform along the thirty welding machines, and deposited in each boot to be used on the welding machines."

What experiments, if any, have you made, Dr. Doan, with the effects of heating on clay, lime and ferromanganese mixture fluxes?

A. I have carried out a large number of different heating treatments. The first one was to heat to 105 degrees to drive off any moisture present as such.

It seemed that that might not be what had been used, so I heated another batch to what happened to be 538 degrees Centigrade. When I tried welding with that under a variety of welding conditions, I got worse results
2174 than with the clay flux which had not been heated.

Then I tried heating it not for just one hour at 538 degrees Centigrade, but heating it for fourteen hours at that temperature, and the results again were worse.

I tried some experiments in which the flux was stirred during heating. I tried some in which it was sealed in a tight container during heating. I tried some in which it was heated in an open gas furnace, but in all these instances the heating operations produced more porosity than the material that was heated only to 105 degrees.

Q. At page 1521 of the record, Mr. Robinoff was asked the question:

"When you were welding with your clay flux process, is it not a fact that you did not know whether the end of the rod was in contact with the molten flux?

"A. I don't know.

"Q. Is it not a fact that you do not know whether your flux was electrically conductive when molten?

"A. I don't know.

2175 "Q. Is it not a fact that you failed to make any experiments or tests about that?

"A. Correct."

Have you, Dr. Doan, made investigations to determine whether or not with a clay-lime-ferromanganese flux made to the proportions that Mr. Robinoff gave me in his testimony, there is any contact of the rod or electrode with the fused pool of flux?

A. Yes, sir; we investigated that thoroughly.

Q. And what did you find?

A. We found that from whatever standpoint we ap-

proached it, we could not find any contact between the rod and the pool of molten flux.

Q. I don't have the exact page in the record, but as I recall it the gist of Mr. Robinoff's testimony was that he had not made any welds with his clay flux process in plates substantially in excess of a half inch in thickness.

Have you, Dr. Doan, made attempts at welding with that clay flux in plates over a half inch thick?

A. Yes. We have made some welds in thicker plates.

Q. What was the gist of your findings?

2176 A. It gave porous welds in every instance.

Q. How did the porosity compare with any porosity you found in the thinner plates?

A. Oh, I wouldn't be able to say. They were both quite porous. I think they were probably more porous than the thicker plates.

Mr. Wolfe: I have two items to offer in evidence at this time: First the series of X-rays of welding action with clay flux, previously marked for identification as Plaintiff's Exhibits 229-A to E, Dr. Nusbaum's X-rays; and, secondly, this set of X-rays of the sample plates that were welded in the course of plaintiff's demonstrations. I offer them as Plaintiff's Exhibit 231, and will ask that the individual radiographs be marked A to whatever appropriate letter is required, later.

Mr. Stewart: If the Court please, I have no objection; but I think Mr. Wolfe will agree there is one note of explanation needed about one of those X-rays, and that is—

Mr. Wolfe: I am going to go through the whole series with Dr. Doan.

2177 Mr. Stewart: You are?

Mr. Wolfe: Yes.

The Court: Admitted.

(Whereupon the said X-ray plates marked PLAINTIFF'S EXHIBITS 229-A TO E; and the said X-ray plates marked PLAINTIFF'S EXHIBIT 231 were admitted in evidence.)

Mr. Wolfe: The X-rays here have on them the exhibit numbers for the plates of which they were taken.

By Mr. Wolfe:

Q. I have here, first of all, Dr. Doan, those for plate 147. That, I believe the schedule shows, was welding on a half inch plate with Unionmelt.

Will you observe those, Doctor and say how they compare with other X-rays you have studied on Unionmelt welds.

A. That is No. 3, I believe. That is a half inch plate—

Mr. Wolfe: That isn't the demonstration. Here is the plate number.

The Witness: I put these numbers on them. That
2178 is demonstration No. 3, of which I think we all have a record.

That shows, as far as this method reveals, two completely sound welds.

2179 Mr. Stewart: May I ask what No. 3 was?

Mr. Wolfe: Unionmelt welding on a half inch plate.

By Mr. Wolfe:

Q. Now, the next plate numbers here are 183. Can you say what demonstration those were from, Dr. Doan? Here is a third one from 183.

A. These are from No. 7 demonstration.

Q. What was that?

Mr. Becker: One-third Unionmelt, one-third Lincoln-weld and one-third clay flux.

The Witness: This very porous weld (indicating) is the clay flux weld.

By Mr. Wolfe:

Q. Pointing to those lines, the heavy black marks?

A. Yes. The next is, I believe, Lincoln and the next is Unionmelt.

The Court: Mr. Wolfe, will you have the witness indicate on the X-rays in some fashion what he is now pointing out?

Mr. Wolfe: Yes. The one to which he pointed as the Lincoln film has an L on it behind the 183, and the Unionmelt has the letters U M behind the 183 on the film
2180 itself.

The Witness: The C is for clay.

By Mr. Wolfe:

Q. What are these small black dots over here in the Unionmelt film?

A. Well, at this point they are apparently small bubbles which came out at the very bottom of the weld; and at this

point they indicate not quite complete penetration through the joint.

Q. Now, what are these films of plate 148?

A. Those are from demonstration No. 4, of which the first half was Unionmelt and the second half clay, in a one inch plate.

Q. The film that was taken of the Unionmelt part has what mark on it?

A. 148-C is the clay and 148-U M is the Unionmelt. The conditions are given in the demonstration sheet.

Q. What significance is shown in those films?

A. The clay flux shows not only centerline porosity but also radial porosity in very excessive quantities. The Unionmelt weld is homogeneous throughout.

Q. The next set here are two films from plate 149. What were those?

A. Those were—

2181 The Court: Let me ask Mr. Doan:

Were these X-rays taken from the top of the weld or the side of the weld?

The Witness: From the top through the section. It is looking down through.

These are demonstration No. 5, clay flux on 5/16ths inch plate, 600 amperes, straight polarity.

This would represent approximately the conditions under which the clay flux was used as set forth in the preamble to the patent.

By Mr. Wolfe:

Q. You mean, of the patent in suit?

A. Yes.

Q. What do those films show there?

A. Well, they show an excessive amount of porosity; not as bad as the one inch plate.

Q. What is that indicated by as we look at the film?

A. Well, the number and size of the dark dots, those being regions of low density through which the X-rays have passed more intensely, and therefore darkened the film.

Q. The last of this series were taken from plate

2182 182. What are those?

A. Those are from demonstration No. 6, automatic welding on a ¾ths inch plate using Lincolnweld 600.

Q. What is the dark region that appears at the top of each of those two films?

A. That is the unwelded portion where the weld metal ran down through the joint and therefore was skipped and not welded.

Q. What is the character of the remainder of the weld there?

A. It is completely sound and homogeneous. The weld is reinforced a little bit above the thickness of the plate and therefore appears a little bit lighter due to its greater thickness.

Mr. Wolfe: We have here half of the plate itself which was welded in the demonstration with clay flux on one half of the weld in the plate and Unionmelt on the other.

2183 By Mr. Wolfe:

Q. What are these fissures or holes that appear here, Dr. Doan, in the clay flux half of the plate?

A. Those are gas cavities where gas was trying to escape and was entrapped in the freezing metal.

Q. That is what is shown as those black blobs or dots on the X-ray?

A. That is right.

Mr. Wolfe: I have another question or two to ask about the Holladay article, if you have made up your minds about an objection.

Mr. Oberlin: I thought we might look that over during the noon recess. There are some questions about it. Are you through with the witness otherwise?

Mr. Wolfe: That last plate we looked at here, just for the record, was Exhibit 148.

Except for this matter in connection with the article we have no further questions from Dr. Doan.

2185 Mr. Wolfe: If the Court please, I renew the offer of this paper from the Franklin Institute Journal.

2186 Mr. Stewart: We have no objection, your Honor. We would like permission, however, to put Dr. Nusbaum back on the witness stand, to explain it in surrebuttal, that is all, because it is a very technical document.

Mr. Wolfe: I do not think that there will be any objection to that, your Honor.

Mr. Stewart: And that may not be necessary; we do not know at this time.

The Court: Very well. The exhibit is admitted.

(Whereupon PLAINTIFF'S EXHIBIT No. 230 was admitted in evidence.)

Direct Examination (Continued) by Mr. Wolfe.

Q. I call your attention, Dr. Doan, to page 1677 of the stenographic transcript, where, in the course of the testimony of Dr. Nusbaum, the following questions were asked and the following answers given:

"Q. Are you familiar with Maxwell's Law of the distribution of molecular velocities?

2187 "A. Yes, sir.

"Q. It is not a fact that that law, or equation, applies in fused salts just as it does in ionized gases?

"A. No, sir, it is not, because the velocities in fused salts are not enough to produce ionization by collision.

"Q. You have considered that point carefully, have you, Doctor?

"A. Yes."

What is your opinion on that, Dr. Doan? Does Maxwell's Law of the distribution of molecular velocities apply in the case of fused salts?

A. It does—

Mr. Stewart: Just a moment, please. I object to the form of the question, your Honor. The question was "just as it does in ionized gases."

Mr. Wolfe: I will modify the question.

Mr. Stewart: There is a difference.

Mr. Wolfe: So that the question will read:

"Just as it does in ionized gases."

The Witness: It does.

2188 Q. Do you find any reference to that in this paper of Holladay's, Exhibit 230?

A. I do.

Q. What page of it?

A. Page 231, the last paragraph.

Q. Would you read it?

A. (Reading.)

"Since glass is an amorphous substance with presumably no crystalline structure, free electrons would probably encounter about the same kind of resistances to their movements that they do in an ordinary gas, and would be acted upon by the electric forces of ionized molecules and other electrons about as in a gas."

Q. The preceding paragraph is what?

A. The preceding paragraph on the same page:

"An explanation of our observed results may probably

be most simply found by employing Maxwell's law of distribution of molecular velocities."

Mr. Wolfe: That is all.

2189 By Mr. Stewart:

Q. Dr. Doan, in considering the process of electric welding described in the first application, the first file wrapper as opposed to the process as described in the second file wrapper about which you have testified, you testified this morning that in the first file wrapper the process was designated as "arc welding", did you not?

A. That is right.

Q. May I call your attention to page 3, lines 8 and 9 of the first file wrapper,—

That is Plaintiff's exhibit number what?

Mr. Stewart: 125.

Mr. Cahill: What is the page?

Mr. Stewart: Page 3.

By Mr. Stewart:

Q. (Continuing)—where I believe at lines 8 and 9,
2190 it is stated, on behalf of the applicants:

"It is the purpose of this application to deal with a new method designated as submerged electric arc welding".

Mr. Cahill: "Submerged arc electric welding", is the way it reads in mine.

Mr. Stewart: "Submerged arc electric welding"?

Mr. Cahill: That is the way it appears here.

Mr. Stewart: That is satisfactory to me.

By Mr. Stewart:

Q. It appears that way, does it not?

A. Yes.

Q. "Submerged arc electric welding"?

A. Yes.

Q. Not just "arc welding"?

A. Correct.

Q. Now, on page 5 of that same document, the following appears, does it not:

"When the arc is struck"—

A. What line?

Mr. Cahill: About twelve lines down.

2191 The Witness: Yes, I have it.

By Mr. Stewart:

Q. (Continuing.) "When the arc is struck, the energy liberated instantly fuses that portion of the flux in the immediate vicinity."

That appears?

A. Yes, sir.

Q. Now, turning to the second application or file wrapper, Plaintiff's Exhibit 126, in the first line it states, on page 1:

"This invention relates to electric welding."

That is correct, is it not?

A. Page 1?

Mr. Cahill: Page 2, it is.

By Mr. Stewart:

Q. The first line of page 2; I am sorry.

"This invention relates to electric welding"?

A. That is correct.

2193 Q. Turning to page 4, the paragraph beginning, "We have discovered", will you locate that?

Q. There appears the following in the original text before any amendment was made:

"We have discovered a novel process of welding which resembles the arc process in many ways but which is essentially different from all arc processes and uses no arc."

That appears does it not?

A. It does.

Q. And further on, or continuing the same quotation, it says:

"As in prior processes the necessary heat is generated in our process by causing a heavy electrical current to flow across a region of relatively high electrical resistance and thence to a member on which the metal is to be deposited, but in our process the resistance is provided not by a body of ionized gas but by a conductive melt."

2194 That appears, does it not?

A. That is correct.

2195 Q. But there was a third application filed, was there not?

A. There was.

Q. Will you turn to that third file wrapper, please, Doctor, applicant's Exhibit—No. 127.

Q. You will find the representation to the Patent
2196 Office, dated November 23, 1935, that will be it.

A. I do not seem to be getting anywhere here.

Q. Can you then turn, Dr. Doan, to the fourth page of that communication.

2197 Q. Which reads as follows:

"The basically novel concept is in fusion, melting by deposition, from an electric current as the source of heat, without the use of a gas-conducted arc.

"Hitherto it has never occurred to anyone that such a thing would be even possible of attainment, as is witnessed by the immense amount of effort put into the development of arc welding."

Now my question to you, Doctor, is this: That statement does radically distinguish, does it not, the basically novel concept, as represented to the Patent Office, in this patent, from electric arc welding?

A. Yes, it does.

Q. Now referring to page 6, which is two pages over, Doctor.

A. Yes, sir.

Do you find there the quotation which begins, "It is noted"?

2198 A. I have it.

Q. Which reads as follows:

"It is noted that the Examiner uses the term 'arc welding' in connection with applicants' process.

"It is pointed out that the present invention does not involve a gas-conducted arc, thereby distinguishing radically from all prior fusion deposition electric welding processes."

That also distinguishes, does it not, Doctor, the process and the method of generating heat, as described in this patent, from all arc processes?

2201 A. I would answer that if the entire paragraph is read the distinction is clear.

2202 Q. Reading the part which I read to you, that does distinguish, does it not, the manner in which the heat generated from all arc welding processes?

A. It distinguishes incompletely.

Mr. Stewart: All right.

By Mr. Stewart:

Q. Now, among the various ways in which electrical energy has been converted into heat for the welding of metals, the arc process is the most generally practiced, is it not?

A. I would not like to make a statement of that kind.

Q. Do you think that is not a clear statement?

A. I am merely saying I am not in a position to answer it either affirmatively or negatively.

2203 Q. Well, I refer you to the opening paragraph of the patent in suit, page 1, column 1, which I read to you:

"Among the various ways in which electrical energy has been converted into heat for the welding of metals, the arc process (which itself takes several forms) is the one most generally practiced."

That is a true statement, is it not?

A. Whether or not it was true at that time, at the 2204 time that was written, I do not know; and what the exact facts are now, I do not know.

Q. In welding the use of what is generally known in the trade as the electric arc is the means by which the heat is generated, is it not, the arc?

A. That is too simple an explanation of the arc process. Heat is generated in the arc process by resistance, though not all of it could be explained as resistance.

Q. Well, is the heat in the Unionmelt process generated by an arc or not?

A. If you define an arc broadly, to include any discharge of electricity through a gas or a vapor, then part of it is developed in that way, by the resistance of that vapor core.

Q. Now, that core is an arc, isn't it?

A. I have just said if you define it broadly, we can agree on that.

Q. Doctor, you are familiar with the fact that electric arc welding can be successfully performed under water, are you not?

A. Yes.

Q. You are familiar with a number of articles that have been written on the subject of welding with an elec- 2205 tric arc under water?

A. I have seen a number of articles and I have seen demonstrations of it.

2206 Q. Doctor, the core of this pool in your schematic drawing there, Plaintiff's Exhibit 167, you believe to be designated as an arc if the definition is broad enough?

A. I do.

Q. And the greatest or the larger proportion of the 2207 current that travels from the electrode to the plate is carried by the charges in that core or in that arc; isn't that a fact?

A. I don't want to speculate. I told you I wanted to measure it, and tried to measure it, and was unable to.

Q. Doctor, may I read you from page 7 of this little document which you prepared for the Court, entitled Conduction of Electric Current in an Ionized Gas or Liquid, which has been admitted in evidence, where you make the following statement:

"Current thus flows throughout the pool between rod and plate. The concentration of heat is greatest at the center or core of the pool, and the composition there is vaporized. The ions and electrons there have a greater freedom of movement, a larger proportion of the current is made up of their charges."

You made that statement in your little treatise, did you not?

A. Yes.

2208 Q. So that the larger proportion of the current, to put it another way, is carried by that arc, is it not?

A. Based on theoretical grounds, that is what I believe to be true.

Q. And if the larger proportion of the current is carried by that arc, the larger proportion of the heat generated is generated by that ionized gaseous medium, is it not?

A. Well, that requires a couple of additional assumptions.

Q. The current generated or the heat generated is in proportion to the square of the current?

A. And to the resistance.

Q. And to the resistance?

A. So I don't want to make that assumption, of course.

Q. But the resistance, Doctor, in the gaseous medium is far less than in the molten medium, is it not?

A. Which would tend to make the heat generated in the gaseous medium less.

Q. Now, in the generation of that heat, the plain fact of the matter is, Doctor, isn't it, that that is the heat 2209 that melts the flux?

A. That is part of the heat that melts the flux.

Q. That is part of the heat that melts the flux.

A. (Continuing) I have melted lots of flux without an arc.

Q. All right, but when you have an arc, there is enough heat to melt the flux, the rod and the plate, is there not?

A. The melting comes from both sources, resistance of a core and from the pool itself. The heating itself occurs at the outside of the pool, while the core is the hottest part, so the actual melting of the flux is done at the outer portion of the pool where no possibility of an arc exists.

Q. But the heat of the arc is radiated outward, is it not?

A. It is.

Q. In your testimony on direct examination, you said that as the electrode moves along successive portions of the flux ahead of the electrode are melted.

A. That is right.

Q. That is from the heat of the arc, is it not?

A. Partly.

2210 Q. You don't know how much heat is generated by the arc, as compared with how much may be generated by the conductive melt?

A. I do not.

Q. You do know, however, that the greater portion is generated by the arc, do you not?

A. I do not. I don't want to theorize and speculate about that division. Theoretical considerations would lead me to that conclusion, but I don't know it.

Q. You don't know it. Now, you said that you could measure the volt drop as between the electrode and the pool of flux, if the pool is there, and I believe you said you measured a volt drop of three volts.

A. That is right.

Q. That does not prove anything about what, if any, current is being conducted through the flux, does it?

A. Are you telling me or asking me?

2211 Q. I am asking you.

A. It does.

Q. How much current?

A. It does not tell quantitatively how much current.

Q. It only tells of an infinitesimal amount, is that not right?

A. No.

Q. How much, then, if it is not an infinitesimal amount? Do you know?

A. No.

Q. The volt drop between the electrode and the plate in some instances was what?

A. 30 volts, or 40.

Q. 40 volts?

A. 30 or 40.

Q. That means that many volts are used up in that part of the circuit, is that not right?

A. That is the potential difference between those points.

Q. The potential difference, or the potential, is the voltage or power that pushes the current through; is that correct?

A. Well, it is not quite "power." Let us say, pressure.

2212 Q. All right, pressure.

A. Yes.

Q. The pressure which pushes the current through.

A. Yes, sir.

Q. But you have no idea as to how much current might be going through the flux—

A. I do not want to speculate.

Q. (Continuing) —the molten flux, when you have a volt drop of 3 volts; you have no idea, have you?

Mr. Cahill: I object to that question, may it please the Court. That identical question has been answered three times in the last five minutes.

Mr. Stewart: I will not press it.

By Mr. Stewart:

Q. Now, on your direct examination, Dr. Doan, you said that when this pool completely submerges the end of the electrode, or, to put it another way, the electrode is immersed in the pool, the electrode, or the end of it, is sealed by that pool, sealed inside; is that right?

A. Yes.

Q. But when you see arc flashes, that seal is broken, is it not?

2213 A. It is.

Q. Then you described the difference between hand welding and automatic welding, this automatic welding, in terms that pointed up the automatic features, that is.

that the operator did not have to judge his arc length, or guide his electrode, whereas, in this process, that is done automatically.

That is not any great distinction between Unionmelt and hand welding, is it?

The Witness: Well, my answer would be that, from the standpoint of the operator, it is a fundamental dis-
2214 tinction.

By Mr. Stewart:

Q. But the distinction is purely between automatic welding and hand welding, is it not, Doctor?

A. Well, that is what you asked for, if I understood your question correctly.

Q. But the distinction is between automatic welding—not necessarily Unionmelt, but it can be anybody's automatic welding—and hand welding, is it not?

A. I do not know of anybody else's that is fully automatic.

Q. The Robinoff process used an automatic head, did it not?

A. Yes.

Q. Made by General Electric.

A. Yes.

Q. And that automatic head controlled the arc length, did it not?

A. Yes.

Q. In the same way as in the Unionmelt process?

A. No.

Q. It was a little different mechanism, was it not?

A. From the standpoint of the weld that was being produced, quite different, yes, sir.

2215 Q. I am talking about the maintenance of the arc length by the automatic machine.

The Witness: Both have aufomatic feed of the wire, and both control arc length by that feed.

By Mr. Stewart:

Q. And that same control mechanism operates to maintain a uniform arc length, whether there is any flux on the seam, or any pool around the electrode or not; is that not correct?

A. Your question is, the same mechanism operates to control the arc length, whether there is any flux around

the seam, or—well, I think it is fair to say "Yes"
2216 to that question.

Q. Now, when you first start the Unionmelt automatic process, there is an arc initially established, is there not?

A. Yes.

Q. And that continues in existence throughout, does it not?

A. No, sir, it does not—not that arc, if that is what you mean.

Q. Not that arc.

A. No, sir.

Q. Initially, that arc generates enough heat in that very small area to melt the surrounding flux; is that not correct?

A. Yes, sir.

Q. And enough heat to immediately start melting the electrode?

A. Yes.

Q. And the edges of the plates?

A. All of those are correct.

Q. And throughout the entire operation, heat is generated in that zone which melts the electrode, the edges of the plates, and the flux; is that correct?

A. Which does a part of the melting.

2217 Q. I said, heat is generated in that zone, Doctor? I did not say by what.

A. Well, I just did not want you to infer that that heat alone did these things.

Mr. Stewart: May I have the question read again, your Honor?

The Court: Yes.

(The question was read.)

A. This heat aids in melting these things.

Mr. Stewart: I did not ask you, Doctor, what generated the heat. I only said that heat is generated in
2218 the welding zone, not by what.

The Witness: Is that what it says?

Mr. Stewart: In the zone around the end of the electrode.

The Witness: I think you said, in the arc.

Mr. Stewart: I did not say "arc".

The Witness: Well, I want to be sure.

Mr. Stewart: Would you read the question, please?

The Court: Well, assume it said "welding zone," that that is in the question. What is your answer.

The Witness: The answer is "Yes".

By Mr. Stewart:

Q. You state that the arc that is initially started does not continue throughout the operation?

A. It does not.

Q. There is, however, an arc which continues, is that correct?

A. Broadly defined, there is.

Q. And that arc, broadly defined, provides heat to melt the electrode, the plate and melt the flux does it not?

2219 A. It does.

Q. You do not know how much, if any, heat is generated by any other means, do you?

A. I do not know exactly how much, but I know that other heat is generated.

Q. But the greater proportion of the heat is developed by the arc, is it not?

A. It is speculative. I have no tests to guide me.

By Mr. Stewart:

Q. Then in the Unionmelt process you cannot say that the flux is the welding medium and that it provides the heating means, can you?

A. I can and must.

Q. How can you?

A. Because the arc is made up of the flux, and nothing else.

Q. The arc is made up of flux and nothing else?

A. They are the carriers, and the principal carriers.

2220 Q. I thought the arc was, you testified, an ionized gaseous medium, some gas vaporizing flux and some evaporized iron; is that not correct?

A. Yes. There is some vaporized iron present; probably a small percentage.

Q. And that is normal to an electric welding arc, it it not—

A. By no means.

Q. —of any type when an iron electrode is used?

A. If you will make clear what you mean by "that" I will try to answer it exactly.

2221 Mr. Stewart: May I have the question read, please?

The Court: Yes.

(Question read.)

The Court: Now can you answer the question?

The Witness: What do you mean by "that"?

The Court: Can you answer the question as it stands?

The Witness: No, sir, I cannot.

The Court: Reframe it, Mr. Stewart.

By Mr. Stewart:

Q. Take an open arc with bare electrode out in the open with air around it. There is iron vapor in the arc, is there not?

A. There is.

Q. Take a coated electrode open arc: There is iron in the arc?

A. There is.

Q. Iron vapor?

A. There is.

2222 Q. Take welding with the Robinoff flux, the clay: there is also iron vapor in the arc?

A. There is.

Q. My question to you was that the presence of the iron vapor is characteristic of the electric arc when an iron electrode is used, is that correct?

A. It is one of the characteristics.

Q. I agree. That is all I am asking you.

A. Yes.

Q. The other gaseous materials that are there depend, do they not, on the surrounding medium?

A. Most certainly.

Q. So that with an open air arc you have air participating; with the shielded arc provided by the coated electrode you have gaseous coating or vaporized flux participating?

A. And air.

Q. And air. In the Robinoff or clay flux, you have some gaseous clay?

A. Yes.

Q. And in Unionmelt you have some gaseous Unionmelt flux?

A. Yes, that is correct.

2223 Q. Dr. Dean, in this article entitled "Resistivity of Vitreous Materials", the experiments here were not conducted at over 500 degrees centigrade, were they?

A. They were not.

Q. And the opening statement indicates that they were investigating the resistivity of various types of glasses?

A. That is correct.

Q. Fused salts can be glasses or they can be in crystalline structure, can they not?

A. Certainly.

Q. If you fuse a glass and do not cool it quickly, it will be in a crystalline structure, will it not?

A. It may.

Q. It may. If it is in a crystalline structure—crystalline lattice, I think you call it—there are no free electrons, are there?

A. There are.

2224 Q. What is that?

A. There are free electrons.

Q. When it is in crystalline form?

A. Yes. Otherwise it would have no conductivity.

Q. Do you believe this article relates to glasses in crystalline form?

A. No, I don't think so, but that isn't what you asked me.

Q. Well, what is the difference in molecular arrangement, Doctor, when a glass—or a fused salt, put it that way, is in crystalline form or in a glass form amorphous?

A. In a glass or amorphous form, the arrangement of the atoms or molecules is completely random; and in the crystalline form there is a degree of order to the arrangement.

Q. The order results from the electrons not being free, is that correct?

A. No, it does not.

Q. Doctor, did you, in the rest of this article, make any calculations as to the resistivity or conductivity of some of these types of glasses?

A. I did, some mental ones.

Q. And the resistance can only be calculated, for
2225 high temperature, higher than 500, by projecting the curves here, isn't that correct?

A. Well, these only go to 500. He develops an equation that he thinks will hold—

Q. Applies beyond that?

A. Yes.

Q. That is his theory?

A. Yes.

Q. The fact of the matter is, Doctor, is it not, that when

you get any one of these glasses or a fused salt in amorphous state, any of these fluxes up around 1500 degrees Centigrade, they become vaporized, do they not?

A. Oh my goodness, no.

Q. What is the vaporization point of Unionmelt?

A. I don't know.

Q. How about 2,000 degrees?

A. Glasses vaporize at 2,000?

Q. Do they?

A. Oh, they have a very small vapor pressure at that temperature.

Q. What about near the vaporization point of steel, 3,000?

A. Well, now, we are beginning to speculate a little bit; I am sorry.

2226 Q. The Unionmelt will vaporize at 3,000, will it not, Doctor?

A. Well, I wouldn't like to say at 3,000; but it will vaporize.

Q. And once it becomes vaporized, the mobility of the ions, the mobility of the electrons, is tremendously increased, is it not?

A. Correct.

Q. Do you know which grade of Unionmelt was used in all your demonstrations?

A. Mostly 20.

Q. 20?

A. We did some with 80 and 90.

Q. The 90 is the subject of a patent—is covered by a patent issued in 1943 to Mr. W. P. Miller, is it not?

Mr. Cahill: I object to what some patent not further defined is alleged to have covered. The patent will speak for itself. No such patent is referred to in the answer here.

The Court: I don't quite understand. Read the question, please.

(Question read.)

2227 The Court: Is that in evidence?

Mr. Stewart: The Unionmelt 90 was used in a chemical chart, although it was covered in the patent in suit. I am only pointing out that the 90, the formula of that, was patented in 1943 by Mr. W. P. Miller.

The Court: Is that prior art?

Mr. Stewart: Not prior art, only it is not the Unionmelt 20.

Mr. Cahill: It is improper rebuttal. This is the first time it has been brought up.

Mr. Stewart: I am only identifying what Unionmelts were used.

The Court: Well, will you restate the question.

By Mr. Stewart:

Q. You didn't use any Unionmelt 90 in your tests, did you?

A. Yes, I did.

Q. Do you know that Unionmelt 90 has the chemical composition consisting of ranges of 36 per cent manganese oxide, 39 per cent aluminum oxide, 19 per cent silicate, and is the subject of a separate patent and not this patent in suit?

2228

Mr. Cahill: I object.

The Witness: No, I don't know.

Mr. Cahill: Just a moment, please.

By Mr. Stewart:

Q. You don't know that?

A. No.

Mr. Cahill: I submit it is improper to go into something at this late date which has not been brought up before.

The Court: Sustained.

By Mr. Stewart:

Q. The original question was, the demonstrations before the Court were all with Unionmelt, were they?

A. They were, as far as I can—

Q. As far as you know, the calcium silicate flux?

A. Unionmelt 20.

Q. And do you know what grade it was, coarse or fine?

A. I made experiments with different grades.

Q. The experiments which were put on as demonstrations before the Court, do you know what fineness was used?

A. No, I don't; but it could be looked up.

2229

Q. Was it coarse or fine, I mean.

A. I don't know.

Q. Doctor, you testified this morning about observing the Defendants' demonstrations of welding under about two inches of silica sand. I believe you stated that you had tried it, and only used one inch, and the arc was visible.

A. That is correct.

Q. When two inches were used in the Defendants' demonstration, the arc was completely submerged, was it not?

A. It was.

Q. And I believe you said that the resultant weld occurs in a peculiar shape because the melting point of pure silica is considerably higher than the melting point of steel, and that is the primary factor, is it not?

2230 A. Oh, now, that—you are asking a lot of things there.

One of the reasons for the characteristic appearance of the weld which you got with silica and I got with silica is the high melting point of silica. There are other reasons.

2231 Q. Silica—

A. (Continuing) There are other reasons.

Q. Silica has a melting point of somewhere between 200 and 300 degrees above that of steel, has it not, doctor?

A. I think it is more.

Q. Yes. So that, when the heat generated by the arc, whether you can see it or not, melts the surrounding medium, which is sand, and that then solidifies over the molten metal before the metal solidifies, that determines the shape of the bead, does it not?

A. It is one of the factors, as I stated this morning.

By Mr. Stewart:

Q. If you would put as much as 50 per cent calcium fluoride with the silica sand, to lower its melting 2232 point, you would get a smooth bead, would you not?

A. I do not know.

Q. Well, putting it another way, if you would put enough calcium fluoride with it to reduce the melting point of the mixture down below that of steel, you would not get the high bead that you saw, would you?

A. That is speculative. I do not know what I would get.

Q. You never tried it?

A. It is an indefinite experiment, that you are describing.

However, I will answer that more fully, if you would care to have me do so.

Q. You talked about welding in a crucible—or at least, melting the electrode by dipping the tip of the electrode into the molten flux, and passing the current through the flux down to the plate.

The electrode, under those circumstances, with the same current, did not melt—

A. The same as what?

Q. Under those circumstances, the current that you used did not melt as the same speed as it would
2233 melt if you were welding with an open arc, did it, Doctor?

A. I did not measure it, and therefore I do not know.

Q. You did not notice that the electrode melted very slowly?

A. All that I noticed was that when we finished the experiment, we had a large lump of steel in the bottom, and we had fed in quite a long length of rod.

Q. And what was the penetration into the plate—none?

A. It was a crucible.

Q. Was there any penetration in the bottom of the crucible?

A. Well, we were building up a pool of steel in the bottom of the crucible.

Q. But did the initial deposit melt the bottom of the crucible?

A. It was a graphite crucible, and you could not melt it.

Q. But you did not measure the rate at which the rod melted, and compare it with the rate at which it would melt if you were using an arc, did you?

2234 A. No.

Q. Now, Doctor, in the X-ray of the plate which has been marked as Plaintiff's Exhibit 183, and which, I call to your attention, was the one with the three different fluxes on it, Unionmelt, Lincoln, and clay:

You pointed out what you designated as porosity in that part which was welded under the clay flux.

That porosity is evidenced by the dark spots there in the center of the welding bead; is that correct?

A. Yes, sir.

Q. And the little dark spots in the plate where the Unionmelt fluxes was being used, you do not call porosity, but you call bubbles; is that correct?

A. The same thing.

Q. That is the same thing.

A. Sure.

Q. There was no porosity in the Lincoln—

A. No.

Q. —part of the weld, was there?

A. That is correct.

Q. Would you attribute that to the difference in 2235 the flux?

A. I would not like to attribute that to anything, because I do not know just what caused it.

Q. Every other circumstance was the same, was it not, to the best of your knowledge?

A. Those welds were made as the second or third batch on that table, and whether some—there is a possibility that some clay flux got onto the copper bar. I do not know. I do not want to attribute it to anything because I do not know. When you try to show off a child, you know what happens.

Mr. Stewart: That is all I was trying to bring out, Doctor.

By Mr. Stewart:

Q. Doctor, if you are welding an automatic welder and no flux at 600 amperes and 30 volts onto a butt edge plate, with no Vee, how long would the arc be?

A. A three-sixteenths inch rod?

Q. Quarter-inch rod.

A. Bare wire?

Q. Bare wire.

A. I would not want to do it.

2236 Q. Well, can we have your best approximation?

The Witness: By "arc length" you mean the distance from the bottom of the electrode to the bottom of the crater, is that right?

I should not ask you questions, should I? I am going to assume you mean the distance from the bottom of the—

The Court: Reframe it so the witness can answer it.

Mr. Stewart: I would like it both ways, the distance from the bottom of the electrode to the bottom of the 2237 crater and also from the bottom of the electrode to the level of the plate.

The Witness: Well, the second would be indefinite, because you would not know the depth of the crater, if that is clear.

The distance from the bottom of the crater I would think would be one-fourth of an inch to—oh, I do not know. It is a constantly varying thing as globules fall off, as the feed rate changes and as the depth of the crater changes. It is going to be approximate.

A. It will depend on how the feed is set, of course. You can get anything you want, almost.

2238 Mr. Stewart: Well, using a Unionmelt head—

The Witness: I do not know what you are coming to.

Mr. Stewart: —with an automatic feed to maintain 30 volts.

The Witness: I do not know what you are coming to, so I want to be careful about it.

Mr. Stewart: That is obvious, Doctor.

The Witness: 600 amps. I have never welded with 600 amps with a bare rod enough to feel competent to say.

By Mr. Stewart:

Q. Well, what would your best estimate be of the arc length?

2239 The Witness: With leeway on either side I would say a quarter of an inch.

By Mr. Stewart:

Q. It would not be over a half inch, would it?

A. These are ungrooved—it is an ungrooved joint?

Q. An ungrooved joint.

A. I will draw a picture of it and see how it would look. 600 amps. I would say for good welding it ought not be over a half an inch.

Q. It would never be an inch long, would it?

A. It should never be an inch long.

Q. It should never be an inch long?

A. No.

Q. And increasing the amperage 30 amperes would not change any of your answers, would it, Doctor?

A. Increasing it by 30?

Q. Increasing it by 30, to use 630 as opposed to 600.

A. Oh. The amperage or the voltage, you mean?

Q. The amperage. Still 30 volts. That would not change your answers, would it?

A. Well, I do not want to be pinned down by speculation of that kind. I do not think it is a fair question.

2240 Q. Is that your answer, Doctor?

A. Yes.

2242 The Witness: Well, obviously, if I cannot answer accurately about 600 amperes, I am completely unable to answer about 630 amperes.

By Mr. Stewart:

Q. A variation of 30 amperes, from 600 amperes to 630 amperes, would not make any measurable difference in the arc, would it?

A. I do not know.

Q. Now, Doctor, assume an automatic machine with the settings for 630 amperes, 30 volts, and a plate, either butt-edge, without any groove, or with a groove, either one, and a layer of clay flux one inch deep on there:

2243 My question is, the arc, at the end of the electrode, would not be more than one inch above the edge of that plate, with the arc covering the entire gap between, would it?

The Witness: I do not know what that means.

By Mr. Stewart:

Q. You could not have an arc extending from the plate up to the end of the electrode more than an

2244 inch in length, at that current and that voltage, could you?

A. Do you mean, that length of the arc would not be more than an inch?

Q. Right.

A. I would not expect it to be so, no, sir.

2245. Q. In your demonstration before the Court with clay flux, you did not heat that clay flux just before it was put on the plate, to be used in the welding operation, did you?

A. We did not.

Mr. Stewart: That is all.

Mr. Cahill: We have no further questions, your Honor.

2246 The Court: I want to ask you one or two questions.

As I understand it, the conductivity, as distinguished between an arc and the molten flux or fused flux, the conductivity of the arc is higher than is the molten flux?

Can you answer that? I believe that was Dr. Nusbaum's statement. Do you agree with that?

The Witness: If you consider that the inner part of the pool next to the core is heated to incandescence, yet is still liquid, its conductivity, as indicated by this paper, is very high.

The Court: Well, let us take at the beginning of the

welding operation with, say, Unionmelt. You first have an arc—

The Witness: Yes.

The Court: —which is not related to the flux material, do you not?

The Witness: That is correct.

The Court: Well, take the arc, and take whatever
2247 you have after the electrode becomes submerged in the flux,—

The Witness: Yes.

The Court: —and assume that after it is submerged, there is a molten flux between the electrode, or around the electrode and the metal that you are welding.

The Witness: Yes.

The Court: The conductivity of the gases, the vaporization in the arc that you had at the beginning is higher than you would have in the molten flux, is it not, or is it?

The Witness: The only satisfactory answer to your question is to measure how much current is transferred through the arc and how much through the molten flux.

The Court: Well, take the resistivity: Would you say that the molten flux has more resistivity than what you would find in the ordinary arc that you have at the beginning of the operation before it has been influenced by the flux material?

The Witness: The difficulty is, your Honor, that
2248 the conduction of electricity through a vapor or gas is not a simple phenomenon. It involves this anode drop and cathode drop, or the anode fall and cathode fall, where most of the heat is generated, most of the resistance is encountered.

The Court: What I am trying to ask you, Doctor, is there a difference in resistivity between the gaseous formation in the so-called open arc and the resistivity of the molten flux?

The Witness: Is there a difference?

The Court: Yes, in amount.

The Witness: Well, it is—almost inevitably there is a difference, yes.

The Court: The resistivity of the molten flux would be higher than in the open arc?

The Witness: I would think so, yes, your Honor.

The Court: What I am driving at, Doctor, if that is true, I am wondering if you agree with Dr. Nusbaum that

if you have an open arc where the conductivity is
2249 high and the resistivity is low, and the flux material which is the opposite, that the greater amount of current would go through the arc.

Now, in the beginning of your welding operations, using a flux material such as Unionmelt, you have an arc first?

The Witness: That is correct.

The Court: How does the transfer—and keeping in mind the tendency of the flow of elasticity going through the arc instead of the molten flux, because of the differences in resistivity—

The Witness: Yes.

The Court: How does the transition come about so that the arc may disappear and the current start to go through the melt?

The Witness: Well, it probably occurs in this way: the first arc is largely an air arc, which was originally in there, then the steel wool, then the granular melt would do most of the conducting, the oxygen and nitrogen.

That is very quickly expelled, and the heat radi-
2250 ated from that arc melts this granular flux, and it closes in and seals the air out.

At that point the arc is flux vapor, that is, the carriers are flux vapor, and air is excluded.

That not only has an important effect on the melting and transfer and deposition of metal from that point on, but, air being excluded, the arc itself is of a different type, made up of these vaporized flux carriers. The arc is the carrier, charged carrier of flux, so that it has changed from what it was at the beginning to a new type of arc.

The Court: This is the final question I would like to ask you.

Do you agree with Dr. Nusbaum's statement that, as between the so-called open arc and the molten flux or melt, fused salt, I believe he said, that current, most of the current would normally go through the arc instead of the flux because of the difference in resistivity and the resultant difference in conductivity?

2251 The Witness: One of my colleagues in this case is going to present the correct data on the conductivity of magnesium silica at the temperatures at which Dr. Nusbaum cited them.

The Court: Do you agree with the general statement that, as between the two, the current would flow in between the arc quicker because there was a choice?

The Witness: There will be a division, and not a choice. It will be a division of current through the liquid and through the vapor core, and what is lacking is an experiment to show how much the division is.

2252 I would like to answer your question by saying, clearly the current will divide, a certain proportion will go through the molten flux and the other portion will go through the vapor core; but I think Dr. Nusbaum's view was entirely wrong in the proportions, and I think that evidence will be shown.

In this paper here, for example, in which conductivity of glass is given ~~only~~ up to 500 degrees Centigrade, the conductivity—I should say the resistivity has increased, in that interval of 500 degrees, from some trillion at room temperature down to a thousand at 500 degrees Centigrade.

Now, when you go on up to 3000 degrees Centigrade and 6000 degrees Centigrade, the conductivity of the molten material becomes very high, and a very substantial portion of the current flows through the pool, through the liquid part of the pool.

For one thing, the integrated total area around the wire is large, as compared with the area of the core, so even if the conductivity were equal—which I don't know

2253 that they are—the amount carried through the pool might still be greater than the amount carried through the core.

It is hard to speculate when you do not have measurements because we do not know how much is conducted through the pool and how much through the core, but the core itself is nothing but flux ions, carriers.

I realize I have not given you a completely satisfactory answer to your question. I know exactly what you want to know, but I just have not any measurements to tell you what that division is. I have tried, because it is an important point.

The Court: Well, one thing I think Dr. Nusbaum said, that I would like to get your viewpoint on. I believe he said that the amount of energy in a molten flux could never be adequate or sufficient to produce a weld. What do you say about that?

The Witness: All I can say is that I have never produced a weld by simple conduction—except in a slag pot—by simple conduction of current through a molten

2254 conductor.

The Court: In that pot did you fuse and melt by the electrode or from another source?

The Witness: From the electrode only. There was no other metal there.

The Court: And the heat was supplied by the electrode?

The Witness: Yes. The reason the heat occurs at the electrode is that when the tip of the electrode is immersed in the pool, the bottleneck—that is, the place that all the current has to pass—is from that immersed tip of the electrode to the surrounding material, and the more it spreads out, the farther away it goes from there, the more it spreads out, the lower the current density is.

It is up here at the end where the current density is high that most of the heating occurs, which happens to be exactly where you want it.

The Court: What I am trying to get is an explanation of this experiment you have said you conducted in the crucible when you put the electrode into the fused flux. Was that flux fused prior to putting the electrode in or did you put the flux in and then the electrode and melt the flux by the electrode?

The Witness: We started just as you do in welding. We put a piece of steel wool in the bottom of the crucible, lowered the electrode on to it and then filled the crucible up with granular flux.

We then withdrew that electrode and formed an arc, an air arc, and then melted that granular material, and more granular material was added until the contents formed the crucible full of moten material, the rod continuing to melt as we heated the flux by the flow of current.

It is not too simple, I realize.

The Court: Those are the only questions I have, but if counsel care to examine with reference to the questions I have put to the witness, you may do so. However, we will take a short recess before we do that.

(A short recess was taken.)

Mr. Wolfe: If your Honor please, there are just one or two items in connection with matters about which the Court was inquiring of Dr. Doan.

Redirect Examination by Mr. Wolfe.

Q. Dr. Doan, in describing the starting of the melting of the flux in the pot, you spoke, I believe, of putting in a wad of steel wool, and having an air borne arc, but it was not clear to me at least from what you said as to whether or not that air borne arc remained in the pot.

A. No, sir, it did not. We altered the current and voltage conditions so that no arc whatever was present, after we had gotten a sufficient amount of molten material.

Q. Now also in connection with one of the matters concerning which the Court was inquiring of you, Doctor, namely, the division of the current between the vapor and liquid flux: I wanted to call your attention to Plaintiff's Exhibits Nos. 172-A and 172-B, weld specimens.

Is there any evidence there, in those welds, in con-
2257 nection with t he width and shape of them, as to the effect of current carried by the liquid flux.

A. Yes, there is.

Mr. Wolfe: Will you put them up, Dr. Doan, so that the judge can see them, please.

The Witness: Yes, sir. In this one—

The Court: Just a moment. Which one are you talking about, now?

The Witness: 172-B.

The Court: All right.

2258 The Witness: In 172-B, where there is no fluoride present, the weld zone is narrow; whereas, in 172-A, in which calcium fluoride was present, and in which the conductivity of the liquid is increased, although by how much I am unable to say, the weld zone is widened, indicating the effect on the weld increasing the conductivity of the liquid material.

Mr. Wolfe: That is all I have, your Honor, unless the Court has some further inquiries.

The Court: Are there any further questions of this witness?

Mr. Stewart: There is just one matter, if your Honor please.

Recross-Examination by Mr. Stewart.

Q. Dr. Doan, taking those other samples, one having been welded with a flux without calcium fluoride in it, and the other, a flux with calcium fluoride in it; you have pointed out that the weld made with the calcium fluoride

in the flux is wider, and does not have as much penetration.

2259 There is not as much penetration because it is wider, is that not correct? The same amount of metal having been melted in each?

A. Well, I have not measured those, and I would not like to say definitely.

Q. In general terms, however, that is correct, is it not, Doctor?

A. I would not want to say that.

Q. The real difference, Doctor, between the one flux and the other, resulting from the addition or absence of calcium fluoride, is in its melting point, is it not?

A. The real difference is in its conductivity, although it may be affected by the melting point.

Q. You put the calcium fluoride in, as the patent itself says, to reduce the melting point, do you not?

A. I do not know what the patent itself says about that.

Q. Well, that is the normal use of calcium fluoride in furnace operations, with welding fluxes, is it not?

A. The normal use of calcium fluoride in furnace operations is to increase the fluidity of the slag.

Q. And that also occurs when the melting point is

2260 reduced, too, does it not?

A. If it is maintained at the same temperature, it has some such effect, yes, sir.

Q. So that, the melting point being lower because of the calcium fluoride, it will spread out over the metal, and not converge the way sand does, for example, when it freezes, will it not?

A. Attributing it to the melting point, I think is an error. I think it is the change in fluidity, in which the melting point is secondary.

Q. When sand is used, Doctor, you get very little penetration, and you get a very narrow bead, because the sand has a very high melting point; is that not correct?

A. Because it provides little or no parallel conduction through liquid.

Mr. Stewart: That is all.

Mr. Wolfe: That is all.

The Court: Is there anything further with this witness?

Mr. Cahill: That is all, your Honor.

(Witness excused.)

Mr. Wolfe: I would now like to call Mr. Brennan, as the next witness.

2261 JOSEPH HARRISON BRENNAN, called as a witness on behalf of the plaintiff, in rebuttal, having been first duly sworn, testified as follows:

Direct Examination by Mr. Wolfe.

Q. What is your full name, please, Mr. Brennan?
A. Joseph Harrison Brennan.
Q. What is your residence?
A. Niagara Falls, New York.
Q. What is your present employment or position?
A. Presently I am chief metallurgist of the Electro-Metallurgical Company and consulting chief metallurgist to the United States Vanadium Corporation.
Q. How long have you been chief metallurgist of the Electro-Metallurgical Company?
A. Since 1944.
Q. What was your employment previous to that?
2262 A. From 1937 until 1944 I was manager of the development division of the Union Carbide & Carbon Laboratory. That laboratory is concerned with production development in the field of high temperature metallurgy.
Q. What, in general, has been your experience in high temperature metallurgy of various kinds?
A. Well, previous to my managerial duties, in the eleven years previous I was a research metallurgist in the same division. Prior to that I was a metallurgist and analytical chemist with the Haynes Stellite Company of this state.
Still prior to that I was an analytical chemist with the Union Carbide & Carbon Research Laboratory in Long Island City, and with the Electro-Metallurgical Company at Niagara Falls.
During my student days I was a laboratory assistant with the United States Bureau of Mines, the Lake Superior station at Minneapolis.
At that time, as laboratory assistant, I had my first contact with high temperature metallurgy, for at that time we were carrying on research connected with the production of ferromanganese in blast furnaces
2263 Q. Did you have anything to do with the manufacture of Unionmelt?
A. I might be said to have had the responsibility for

the production of most of the Unionmelt that has been made to date.

Q. In connection with the manufacture of Unionmelt Grade 20 have you had occasion to make any observation of its action or lack of it as a fused liquid conductor?

A. I think that our method of manufacture is illustrative of its conductive properties.

Q. Will you tell us about that, please?

A. Unionmelt at the present time is made in our high-powered furnaces, such furnaces being about ten and a half feet in diameter. The electric current is introduced through three electrodes which are ranged delta fashion in the furnace. In the initial start-up of such furnaces, we lay a train of coke, an amount equivalent to a couple of shovelfuls of coke, on the bottom of the furnace, to make a contact between the electrodes which are fixed relative to their horizontal movement, but move only vertically.

The electrodes are brought down upon the train of
2264 coke in direct contact with them, and the coke heats up by resistance so that we get a small hot batch of coke to start with.

We feed the materials constituting the Unionmelt charge onto that bed of coke and in a matter of only a few minutes we have a pool of fused Unionmelt. The balance of the charge is fed to that pool. It is only a matter of a few minutes until the electrode tips are submerged in the pool, and in our typical batch of production, which is of the order of five tons, the electrodes will be submerged to a depth of about ten inches in that pool.

The liquid surface prevailing on the bath, the electrodes are completely submerged. There is no visible arc. The current is of the order of eight to twelve thousand amperes per electrode.

The furnace will produce a five ton charge in just a little over an hour, and typically in continuous operation we will produce up to 100 tons in a 24-hour cycle.

It is the practice, from batch to batch, to leave a small heel—by "heel" I mean a small liquid pool—of the
2265 molten Unionmelt in the furnace to facilitate the next start-up, so that we can run as much as four or five days' continuous operation in that furnace and never have any arc whatsoever.

That is, we dip the electrodes right into the molten Unionmelt, feed the successive charges, pour the Union-

melt except for this small residue, and then start in with the next batch.

Q. All of the heating comes from electric conduction in the liquid, is that right?

A. All of the heating comes from the electrical conduction in the liquid.

Q. Now, the other day in the course of Dr. Nusbaum's testimony—you were here and heard his testimony, were you?

A. I was.

Q. Beginning at page 1714 in the record the question was put to him:

"Q. Doctor, is there available information showing the comparative numerical values and conductivity of fused salt, in treatises based on technical experimentation? The question is, is there.

2266 "A. Yes. As I have stated before, on page 2020, the third volume of Landolt-Bornstein, the electrical conductivity is given for magnesium silicate."

Then, continuing on page 1715:

"That quantity can be changed to electrical resistivity, to 577,000 per centimeter cube.

"Iron of that same temperature, slightly higher, has a resistance or a resistivity of .000,255.

"This (indicating) is higher in resistance by the number of times this quantity is contained in that, which is on the order of a million times. It can be verified by reference to the Smithsonian Official Tables, also to Landolt-Bornstein."

At that time he wrote these figures which are still on this paper on the easel.

The next question:

"Can you reduce that to a little more simple language, your comparison as to the resistivity?

"A. They are both resistive. The resistivity is 2267 the resistance of a centimeter cube of any given material.

"Q. And conductivity would be 1 over that?

"A. That is right."

Then at a later point he was asked, page 1716:

"What is the temperature for that silicate measurement?

"A. The silicate measurement is 1,425.

"Q. Centigrade?

"A. Centigrade. The iro., this quantity here, is 1,535 degrees Centigrade."

Now, have you, Mr. Brennan, checked those matters in the third volume of Landolt-Bornstein at page 2030?

A. The reference does not occur at page 2030, so that is obviously an error. There is no reference on that page to magnesium silicate.

However, at page 2039—which is doubtless the page meant—there is a reference to conductivity of magnesium silicate.

Q. And what do you find as to the accuracy of the figures which Dr. Nusbaum gave?

2268 A. The important thing to me is that at the temperature indicated magnesium silicate is not in a liquid state. The table refers specifically to the ortho silicate of magnesium, containing two molecules of magnesium oxide to a molecule of silica.

The melting point of that substance given by several authorities is of the order of 1900 degrees Centigrade; so the material must have been in the solid state in this table.

Q. At what sort of a heat?

A. At 1,425 degrees. The table actually extends to 1,428 degrees, by my calculation.

That must be calculated, since the temperature is given reciprocally.

Q. So there is no comparison there of liquid conductivities?

A. There is no comparison of conductivities whatsoever.

There are several references, good references, in the literature, on the melting point of that compound. One is the United States Geophysical Laboratory, which is reported in International Critical Tables and re-
2269 ported in Fulton's Principles of Metallurgy.

Q. As a part of your work, have you had any analyses made from time to time of Lincoln 660 flux?

A. Yes. That has been done from time to time.

Q. What, if anything, were you able to ascertain from those analyses as to the proportioning employed in the Lincoln flux?

A. The proportioning is approximately that employed in a metasilicate.

Q. What familiarity, if any, do you have with manganese ores?

A. It was part of my activities during almost the whole of my professional career. I have been concerned with the smelting of manganese ores for the production of manganese alloys.

2270 Q. Do you know anything of their natural appearance?

A. I think I can say I am familiar with every manganese ore which has passed in world trade for the last twenty years.

Q. What if anything can you say as to the presence of barium and strontium in manganese ores?

A. Barium is inevitably in manganese ores. It occurs in varying amounts in ores from different sources, but is always present.

As to strontium, I have not quite as large a knowledge of it, having confined my observations to only a few ores. I think in one specific instance—

Mr. Stewart: Is this one?

The Witness: I found one ore, in the Three Kids Mine in Nevada, which contained a quantity of strontium. It is probably present in a great many ores, but not all.

By Mr. Wolfe:

Q. What about calcium?

A. Calcium is also present, in varying amounts, in manganese ores.

2271 Q. I would like to call your attention, Mr. Brennan, to Plaintiff's Exhibit 194, which was originally produced by Dr. Willard.

In the course of Dr. Booth's testimony, he was questioned in reference to some matters which appeared there, particularly in connection with the components of the Lincoln flux.

At page 1788 of the record, it appears that Dr. Booth was asked:

"From your knowledge of the manner in which the flux"—referring to the Lincoln flux—"is compounded, is the ferric oxide there as an impurity, or intentionally included?

"A. It certainly is an impurity.

"Q. How about the alumina, in that small amount?

"A. The alumina is certainly an impurity. Both of them come from the manganese ore.

"Q. Does either of them have any useful function in the composition, to the best of your knowledge and belief?

"A. No."

Now, can you, Mr. Brennan, on the basis of your
2272 knowledge of materials of this kind, say whether or not the alumina in the percentage indicated there, in the Lincoln flux, has any useful function?

A. Yes, sir; alumina in this flux has the very useful function of facilitating the formation of glass, on chilling. While it is not absolutely impossible to make a glass in its absence, it is much easier to make a glass in its presence.

Q. What have you to say about the function or lack of function of calcium oxide, or CaO, in the amount that is indicated there, in the Lincoln flux?

A. Well, the calcium oxide, of course, is another flux, like manganese, and is in there for the same purpose.

Q. Is it necessary to take any account of that quantity of calcium oxide?

A. I think, for an understanding of any substance of this type, when we are considering its acidity and viscosity, we have got to take into account all of the acids, and all of the bases.

Q. In such calculations which you make, how do
2273 you class manganese?

A. Manganese is a base.

Q. Could you give us some particular examples, where you have used such calculations.

A. Well in the production of manganese alloy, such as ferro-manganese, silico-manganese, and the like, we have the problem of controlling the slag analysis.

Specifically, to control the metal analysis, we must control the composition of the slag, and we try to do that with as much precision as possible, so that in, say, a typical smelting, in the production of silico-manganese, we will design the slag to a very definite analysis, and a very definite base ratio.

In such calculations we will take into consideration all of the bases present, barium, lime and manganese, and manganese in such slags always forms part of the base.

Q. Now, turning to a somewhat different matter, Mr. Brennan: The Defendants have introduced in evidence here several early patents having to do with electric furnaces, and furnace slags, and have at various times made reference to such materials.

What familiarity if any do you have with furnace
2274 slags used in industry?

A. Well since part of our business was the production of alloys for the steel industry, we have, over all of the years, in my professional experience, made steel and iron, and I am quite familiar with the smelting art, in the production of both steel and iron.

Q. Well now will you review for us, just very briefly, how furnace slags used in the steel industry, for example, and particularly in such electric furnaces as those of the patents which the Defendants have introduced, compare chemically with Unionmelt.

A. Well, to answer that question properly, we must consider the very reason that we have a slag in any smelting or refining operation, and most usually the function of such a slag is to remove gangue materials, that is, the earthy components of the ore; to refine from the metal undesirable materials, undesirable elements, such as phosphorous and sulphur; and third, in certain steel refining practices, to act as a carrier for the refining agent; but the prime purpose of a slag is also to carry away the waste of the process.

2275 Slags, specifically, in each part of the steel making process, are designed specifically for that purpose.

That does not make them too usable in a welding process, because fundamentally these slags are taking out of the steel, phosphorous, sulphur and the like, and that is intended to be out, and not in the steel; and its use in a welding flux would reintroduce it.

Q. Now about some specific types of steel furnaces, Mr. Brennan.

A. Well, the largest steel production is made in the basic open hearth furnace. In the steel trade the word "basic" or the word "acid" refers both to slag composition and to the lining material of which the furnace is made.

Basic open hearth steel slag is, as the name implies, highly basic. It can be said to have three molds of lime to one of silica. The silica that is in it is derived from the oxidation of silicon from the pig iron that is introduced in the process.

2276 It will carry a very notable amount of phosphorous, and one of its principal functions is to eliminate phosphorous from the steel.

In the basic electric furnace steel practice there are two types of slag; a basic slag, similar to the open hearth, whose function is to refine out the carbon and pick up the phosphorous; and the secondary finishing slag, the second slag that is put on the process, which contains calcium carbide, and is intended to desulphurize the steel. Such slag contains both carbon and sulphur, and would not be useful in a welding process.

There is steel production by acid open hearth and acid electric, particularly in the production of steel castings. Such slags are very high in silica, and they are outside of the normal useful range of welding composition because of their rather low heat conductivity, and again, because of the fact that they contain the deleterious impurities refined from the steel.

Those furnace slags, which are the calcium-
2277 magnesium-aluminum silicates—are also notably contaminated with sulphur, because of the coke that is used in the process.

So, too, with cupola slags, which derive from the simple melting of iron.

2278 The Witness: (Continuing) The function of cupola slag primarily of course is to flux the sand that is carried in by the return scrap from the process, and to flux the ash of the coke out; and because coke is used, such slags are notably high in sulphur, and are probably the least well-controlled slags of the entire steel industry, because there is no basic knowledge as to the amount of sand that goes into them with the return castings.

Slags from the copper industry likewise. The prime purpose in copper smelting is to convert natural sulphide into a concentrated sulphide, called a matte, and that is a copper-iron sulphide; and such slags are notably contaminated with sulphur, and are useless in a welding process of this type.

The slags are designed for the use to which they are put. They are not designed as welding compositions, and their primary function, as I have pointed out, is the
2279 removal of impurities.

By Mr. Wolfe:

Q. Well, now, going to another and different matter. Mr. Brennan: When, if you know, was the first commercial heat of Unionmelt Grade 90 shipped?

A. I had occasion to look that up, and the first shipment, the first commercial shipment that is, was made on May 6, 1940.

Q. Have you prepared a barium silicate welding composition and a strontium silicate welding composition, pursuant to the directions of the patent in suit?

A. I have, several.

Q. Do you have samples of those here?

A. Why, samples were brought here, yes, sir, although I personally do not have them.

2280 Q. Are these the samples (indicating) to which you have referred, Mr. Brennan?

A. This is one of them, yes, sir—yes, these are the samples.

Q. To whom did you send any such materials for welding tests?

A. I sent some to Mr. Clapp here.

The Court: Who?

The Witness: Mr. Edward Clapp, who is present here, your Honor.

Mr. Wolfe: If the Court please, Mr. Clapp will be our next witness, and I shall ask him about these welds which he made with this material.

Mr. Oberlin: We shall object to any evidence touching any welding allegedly made with these materials, of which we have not heretofore been given any notice, and of which no duplicate samples have been furnished us.

2281 Mr. Wolfe: No notice was required to be given, your Honor, of anything except those materials which were to be demonstrated, or introduced in evidence. I do not intend to offer these in evidence.

I have produced them here for the convenience of opposing counsel, for inspection, if they desire. The welds, however, we shall introduce.

Mr. Oberlin: I do not see what this is in rebuttal of, your Honor,—the introduction of these samples.

The Court: Well, there is no question pending at this time, and I think I shall wait until a question has been propounded, to which you specifically object.

You may renew your objection, whatever objection you have, to such question as may ensue.

Mr. Wolfe: That is all.

2282 *Cross-Examination by Mr. Stewart.*

Q. Mr. Brennan, in making your Unionmelt in the electric furnace, I believe you said you used 8,000 to 12,000 amperes per electrode.

A. Yes, sir.

Q. And you had three electrodes.

A. Yes, sir.

Q. What do you call that arrangement of three?

A. Delta; it is like the Greek letter Delta. That is the usual way of expressing it.

Q. An equilateral triangle?

A. Yes, sir—that perhaps would be a better way of saying it.

Q. The points of an equilateral triangle?

A. Yes, sir.

Q. And are they in phase with each other?

A. It is a standard three-phase circuit.

Q. A three-phase circuit?

A. Yes, sir.

Q. So that your current is going between your electrodes?

A. Yes.

Q. And not from your electrodes to the bottom of

2283 your furnace?

A. No.

Q. What voltage do you use on each?

A. The voltage is in the range of 300 to 400 volts.

Q. Three to four hundred volts?

A. Yes.

Q. And the magnitude of the contents there is, I believe you said—what? How many tons?

A. About five tons, is a typical batch.

Q. About five tons.

A. Yes.

Q. What temperature did you raise that melt to?

A. We usually finish them at about 1500 to 1550 degrees Centigrade.

Q. Do you know the vaporization point of Unionmelt 20?

A. I do not.

Q. But it certainly is above 1500 Centigrade, is it not?

A. I would not know. I have no knowledge of the vaporization point.

Q. When you heated this melt up to 1500 it did not vaporize?

A. Oh, no; not in any appreciable quantity, at least.

Q. You are familiar with manganese ores. Do you
2284 know of any manganese ore that you can purchase commercially that does not have a small amount of alumina in it as an impurity?

A. No, I do not.

Q. Manganese ore as purchased, particularly outside of this country, is considerably more expensive than an equivalent amount of calcium oxide or raw material to get calcium oxide out of, is it not?

A. Oh, yes. Manganese is always more expensive than lime.

Q. Much more expensive than lime?

A. Yes.

Q. It would be a very expensive proposition to try to take that small amount of alumina out of the manganese ore, would it not?

A. Yes. I rather think it would.

Q. In your analysis of Lincolnweld 660 flux I believe you found no more than 1.8 per cent of alumina; do you remember?

A. I do not have the analysis before me. Just a minute, please. 1.88, yes.

Q. 1.88?

A. Yes.

Q. Not over 2 per cent?

2285 A. That is right.

Q. Is that normal, or is that low or is that high with regard to the normal amount of alumina you expect to find in manganese ore?

A. Well, the alumina content of manganese ore varies quite widely too, so that there is not anything that one can speak of as normality.

Q. How high would it appear?

A. Manganese ores, passing in commerce, contain from as little as 1 per cent alumina to as much as 8 or 10.

Q. So that the normal limits—I mean, the lower and higher limits might go from 1 to 8 or 10?

A. Yes.

Q. It is not over 2?

A. That is right. I am speaking of the ore now, not of this flux.

Q. Yes. Then you said that the alumina helps to some degree in the cooling process to make a glass out of this flux as it goes to a crystalline substance, is that correct?

A. That is right, and for that reason we add it deliberately in our composition.

Q. You will recall, will you not, that it was found
2286 first as an impurity in the ingredients?

A. No. I do not recall that it was found first in our material.

Q. You did not have it in, but the inventors did?

A. I am not aware of what the inventors found.

Q. Mr. Brennan, handing you a patent bearing the number 2,308,194 issued January 12, 1943, to Wilbur B. Miller, will you tell whether or not that patent includes in its coverage the specification of Unionmelt No. 90?

Mr. Cahill: That is objected to as already asked, and your Honor has sustained an objection to it.

Mr. Stewart: He mentioned it in his direct.

Mr. Cahill: He did not mention the patent in his direct, if your Honor please.

Mr. Stewart: He mentioned Unionmelt 90.

Mr. Cahill: He mentioned Unionmelt 90 in his direct because—

Mr. Stewart: Certainly he knew—

The Court: If you start talking about Unionmelt 90, can you limit it to what you want to bring out about it?

2287 Mr. Cahill: Unionmelt 90 is nothing that has been introduced, if your Honor please, at this time.

The Court: I know, but there was a question asked by Mr. Wolfe as to when was the first shipment of Unionmelt 90.

Mr. Cahill: That was responsive to the deposition of Mr. Keir that was read by the Defendants on their case in chief. This is, therefore, not within the scope of the direct on rebuttal.

This is not new matter gone into on the direct of this witness. It was responsive to the deposition of Keir which these people read for the Defendants.

This is going into a matter that is not pleaded in any pleading in this case and has not been touched upon heretofore in any respect.

The Court: What is the purpose of this evidence?

2288 Mr. Stewart: Your Honor, the purpose of this is to clarify one misleading point. This middle bottle down here (indicating) is put in as Unionmelt 90 as though

it were in the patent in suit. I am only trying to bring out that it was the subject of a separate and later patent.

Mr. Cahill: That is a matter of argument, if your Honor please. If the defendants have thought there was anything to that, it was their duty to have pleaded it. I submit you cannot, at the last minute—

The Court: Is that chart in evidence, with that substance?

Mr. Cahill: Yes.

Mr. Wolfe: Yes.

Mr. Cahill: That chart has been in evidence since before our case was rested. They had their opportunity.

The Court: It has on it a bottle which assertedly is Unionmelt 90?

Mr. Cahill: Which was put in our main case, not in our rebuttal case. That was something they could
2289 have gone into, had they wanted to, in their case in chief.

It was something of which they should have given notice in their answer. It is entirely improper rebuttal.

The Court: How does it prejudice you by having it come in now?

Mr. Cahill: Well, it prejudices us, in the sense that if they go into something new at this time we will have to go back into this matter ourselves, and I take it the purpose of rebuttal is simply to answer that which was put in in the defendants' case.

There was nothing in the defendants' case on this point. Therefore it is improper rebuttal.

The Court: I don't quite understand your position, and I am still at a loss to know of what importance it is from any standpoint.

Mr. Oberlin: They bring in the No. 90 in their rebuttal, your Honor.

The Court: They say you brought it in, and you didn't open it up in your answer.

2290 Mr. Oberlin: They brought it in in rebuttal, your Honor, and we are simply identifying what the No. 90 is. Perhaps the witness can identify it some other way.

The Court: Can you identify it as to what it contains?

Mr. Oberlin: That is why we asked him to do it. If we can't do it that way, perhaps the witness can do it some other way.

The Court: If it involves bringing in a patent, I will sustain the objection.

Mr. Oberlin: This is plaintiff's own patent.

The Court: If it brings in a new issue, I will sustain it. If you are going to show what is consists of, you may proceed.

By Mr. Stewart:

Q. What is the general chemical analysis of Unionmelt 90?

Mr. Cahill: This I object to. Counsel was furnished a sample of Unionmelt 90, and there is no sense asking the witness for it. It was given them in writing before
2291 the start of this trial.

The Court: It seems to me if they know it and you know it, there is no reason why it should be withheld from the record.

Mr. Cahill: It isn't being withheld from the record. It was furnished to counsel before the trial started. There is no dispute on the composition of Unionmelt 90. It is just not a proper subject of examination at this time, because it was given counsel before the case started. It is just not a proper subject of examination.

The Court: There must be some latitude. Objection overruled.

The Witness: Repeat the question, please.

(The question was read.)

The Witness: You understand, I do not remember the exact analysis; but I would characterize 90 as a manganese silicate containing calcium fluoride.

By Mr. Stewart:

Q. And what percentage of alumina, Mr. Brennan?

A. Oh, pardon me; that is also present.

2292 Q. About 18 per cent, is it not?

A. That I could not say definitely. I have it in my notes.

Q. It isn't one or two per cent? It is eighteen or twenty?

A. No, a considerable amount is present.

Q. There is also a fair percentage of—what percentage of calcium fluoride, do you recall?

A. It is on the order of five per cent, as I recall.

Mr. Stewart: That is all.

Mr. Cahill: That is all, Mr. Brennan.

(Witness excused.)

Mr Wolfe: Mr. Clapp.

2293 EDWIN A. CLAPP, recalled as a witness on behalf of the plaintiff, in rebuttal, having been previously sworn, testified as follows:

Direct Examination by Mr. Wolfe.

Q. You have been previously a witness in this case, haven't you?

A. Yes.

Q. You received, did you, the barium and strontium welding compositions that Mr. Brennan mentioned?

A. Yes, I did.

Q. Did you make test welds with them?

A. I did.

Q. Do you have the test welds with you?

A. Yes; the test welds are here in the court room.

Q. Will you state the welding conditions under which those were made?

A. They were made in half-inch plate—

Mr. Oberlin: If the Court please, we object to any further reference to this composition to which the question refers. Any welds made with them are improper re-
2294 buttal and have no bearing whatever.

The Court: To what evidence that the defendants brought forth, in the nature of affirmative evidence or new evidence, is this directed?

Mr. Wolfe: If the Court please, as a matter of fact, it is directed primarily to points that they brought up on cross examination of our witnesses in our case in chief.

The Court may recall that they pressed both Mr. Kennedy and Dr. Willard on the subject of barium and strontium silicate welding compositions; and in view of that, we had Mr. Brennan prepare the compositions and Mr. Clapp make the test welds, in the interval that was passed, and this is our first opportunity to show the results of that experimentation.

The Court: Other than the question of the time element, wouldn't it be a proper subject of direct examination as distinguished from the rebuttal?

Mr. Wolfe: I think that is probably so, in view of
2295 the fact that, so far as I know, the defendants did not undertake to refute the testimony which they elicited on cross examination of our witnesses; but because of the time element involved, it wasn't feasible to bring this—

The Court: As I understand it, you are introducing this in the nature of corroborative evidence of testimony given by plaintiff's witnesses on cross examination?

Mr. Wolfe: That is right.

The Court: In their main case?

Mr. Wolfe: That is correct.

Mr. Oberlin: The testimony of those witnesses merely elicited their knowledge of the possibility of making such welds. That was all that testimony was directed to.

The Court: If it is merely in corroboration, it stands uncontradicted.

Mr. Oberlin: It is certainly not proper rebuttal.

Mr. Wolfe: I think that there was no contradic-
2296 tion—at least, it doesn't occur to me at the moment—
at any particular spot in the record.

Perhaps the defendants are willing to state now that there is no contradiction of Dr. Willard's testimony.

Mr. Byron: We are not going to make any such statement.

Mr. Oberlin: That was gone into on either the direct or cross examination of Dr. Willard.

Mr. Wolfe: That was the occasion when Mr. Oberlin wanted to know if he would stake his professional reputation on the possibility of making a weld.

The Court: Unless there is some rule of law, from the standpoint of time or surprise or not being prepared to submit the evidence, in that it was not foreseeable in advance, it seems to me this is not within the realm of rebuttal evidence.

Mr. Wolfe: I think we must properly rely on your Honor's discretion to permit it here, in view of the time element.

2297 The Court: I haven't heard your views on the objections, so I will withhold my ruling until I have heard those.

Mr. Oberlin: As stated, I think it is not proper rebuttal testimony, and admittedly is not rebuttal of any evidence produced in defendants' case.

The testimony just sought to be supported apparently is testimony given in plaintiff's prima facie case, and evidently they didn't think it necessary to produce any testimony there for us to meet, if that was required.

The Court: As I understand, it wasn't in existence at that time.

Mr. Wolfe: No, it wasn't. We had to make the flux and make the weld from the flux.

Mr. Oberlin: As I stated, the testimony, as I recall it, related wholly to the then knowledge of Dr. Willard, the witness, as to the efficacy of these fluxes for welding purposes. That couldn't be supported by any evidence these other witnesses could give without their experimenta-
2298 tions.

The Court: In the absence of any testimony in refutation, or the opening up of this subject by defense witnesses, I will sustain the objection.

Mr. Wolfe: May we have these exhibits marked for identification, the samples of the flux which were used and the sample plates.

The four samples of flux, those will be 232-A, B, C and D, and the two plates 233-A and B.

(Whereupon said articles were marked Plaintiff's Exhibits 232-A to D and 233-A and B for identification.)

Mr. Wolfe: And I would like to make a formal offer of those in evidence; and I suppose the ruling will be the same.

The Court: The record will show they are offered, and the offer denied and the objection sustained.

By Mr. Wolfe:

Q. Have you had any experience, Mr. Clapp, in inspecting welds?

A. Yes, considerable.

Q. Where, and for what purposes?

2299 A. To determine their acceptability commercially.

Q. And where have you done such work?

A. In our own laboratory, primarily.

Q. Over what period of time?

A. The last twelve years.

Q. Have you had an opportunity to examine Defendants' Exhibit 150, which is a weld allegedly made with some reproduction of a flux from the Miller patent?

A. Yes, I have.

Q. What did you find as to the quality of that weld?

A. The weld would be unacceptable commercially, because of cracking.

Q. Did you have a glass there that might make it easier to show the cracking you are speaking of?

A. Yes.

It will be necessary to examine this quite closely, as the lens is of short focus.

You can see the cracks along through the central portion of the weld, together with some transverse cracks here (indicating).

Mr. Cahill: If your Honor please, while we are on this Exhibit 150, subject to the approval of the Court, it has been stipulated between counsel that this exhibit
2300 may be physically cut in half, so as to leave thereon merely the bead purportedly made by Lincoln and the bead purportedly made by Miller.

Mr. Oberlin: The lower two beads were not referred to, apparently, in anyone's testimony; and the other portion of the plate will retain all the data that were referred to by witnesses.

The Court: Read the last answer of the witness.

(Answer read.)

The Court: Will you point out some cracks there?

The Witness: Yes, sir.

Mr. Wolfe: Here is another glass that may be of some help. It has a little larger field.

The Witness: There is one there (indicating). There is a crack that extends for some distance, right on the centerline of the weld.

2301 There is also a crack over here (indicating).

By Mr. Wolfe:

Q. Have you conducted any tests of attempts to substitute the flux of that Miller patent for Unionmelt, in making a weld?

A. You refer to the borosilicate?

Q. Yes.

A. Yes, I have.

Q. What material did you use in making that test?

A. I used half inch thick steel plates, standard Oxweld No. 36 welding rod, and I have some notes here on the actual operating conditions.

The weld was made at 750 amperes, 30 volts, 12 inches per minute, with a 1-5/8ths inch burden, and a ¼ inch rod.

By Mr. Wolfe:

Q. Do you have a sample weld made with that material?

A. Yes. I have a section of it here.

Q. Do you also have an X-ray of the weld?

A. Yes.

2302 Mr. Wolfe: I will ask that that sample section be marked for identification as Plaintiff's Exhibit No 234.

(Whereupon the article referred to was marked Plaintiff's Exhibit No. 234 for identification.)

Mr. Wolfe: I will ask that the X-ray be marked for identification as Plaintiff's Exhibit 235.

(Whereupon the article was marked Plaintiff's Exhibit No. 235 for identification.)

By Mr. Wolfe:

Q. How was this section made, Mr. Clapp?

A. It is a longitudinal section through the portion of the length of the weld. Inasmuch as the X-ray indicates that the weld was cracked both longitudinally and transversely, this particular section shows up the cracks more readily.

Q. Can you show those cracks in that sample to the Court?

Mr. Byron: We have no objection.

Mr. Wolfe: They may be easier to see there.

2303 The Witness: These are readily visible to the eye, and will be seen as small, fine vertical lines scattered at frequent intervals all the way along the length of the specimen.

By Mr. Wolfe:

Q. Will you put them in the box there?

A. Yes.

Q. What is to be observed from that X-ray?

A. This radiograph shows numerous transverse cracks scattered at frequent intervals throughout the weld. In fact, you can see here they are spaced about one-eighth of an inch and one-sixteenth of an inch apart. There is a considerable number of them.

Mr. Wolfe: I offer in evidence the specimen and the X-ray which were previously marked for identification.

Mr. Stewart: No objection.

The Court: They may be admitted.

(Whereupon PLAINTIFF'S EXHIBITS NOS. 234 and 235 were admitted in evidence.)

Mr. Wolfe: Did you make any check of the physical properties of the weld?

The Witness: Yes, I did. We obtained all metal 2304 tensile specimen from the deposit, and upon testing,

no evidence of yield point was found because the material was as brittle as glass.

The ultimate strength was only 7,480 pounds, and the specimen exhibited 0 elongation and 0 reduction of area. It had no ductility whatever.

By Mr. Wolfe:

Q. Were you present last week at the demonstrations conducted before the Court at the Graver plant by the Defendants?

A. Yes, I was.

Q. Did you in particular observe their demonstration No. 2 in which welding was done with a coated rod, I believe, with Lincoln type L.H. 70, under a layer of Lincoln 660 flux?

A. Yes. I saw that.

Q. Have you had any experience with welding with coated rods under Unionmelt or Lincoln flux?

2305 A. I made some tests in the laboratory quite some years ago with coated rods under Unionmelt and recently made some additional tests.

Q. What did you observe as to the type of coated rod that was employed in that demonstration?

A. It appeared to be a relatively new type of coating, a lime coating designed to produce low hydrogen in the weld metal.

Q. What did you observe as to the lengths of rods which were used?

A. The rods were approximately half of the length they would normally be for commercial usage.

Q. What purpose would that serve?

A. Well, the welding itself was conducted at a current of approximately 600 amperes, which is at least twice the normal current for such a rod diameter. The rod was three-sixteenths inch rod, three-sixteenths of an inch in diameter.

Had that current been used on a full length rod it would have heated up excessively and would have been very, very difficult to operate. In fact, the coating may have chipped off the rod.

Q. What observation did you make as to the voltage employed?

2306 A. The voltage was approximately 50 volts or higher. The voltmeter attached to the equipment at

the time of welding had a miximum reading of 50 volts, and the needle was right up against the stop pin during most of the operation.

Q. What, in your experience, have you found to be the condition of the rod tip when you attempt to use a coated rod under, say, Lincoln 660 flux as compared to its condition after you have been welding out in open air under normal conditions, with the coated rod?

A. Well, the type of slag or flux adhering to the end of the electrode will be markedly different. In the case of the Lincoln 660 flux a glassy material will adhere to the end of the rod itself, in the little cavity formed by the original sheath and the melting of the rod.

In the case of ordinary operation with such an electrode, if any slag adheres at all it will usually be crystalline in nature and similar in color to the coating.

Q. Where does that glassy deposit come from?

A. It obviously can come from only one place, the fused Lincoln 660 flux.

2307 Q. Have you examined the rod ends which defendants introduced in evidence here from the demonstration runs that they made?

A. Yes, I have. One of them was dropped, as I observed, at the demonstration and the material on the tip of the rod has been lost.

The other one, however, that was employed for the test under the 660 flux shows the bright, glassy—or rather, black, glassy slag adhering to the tip of the metal rod.

The second one—or rather, the third electrode used for the third deposit which was in the open air shows crystalline slag adhering to the rod.

The Court: Do you have those here? I thought they were in evidence.

Mr. Wolfe: Yes. They are in evidence.

Mr. Stewart: They are in evidence.

The Witness: This is the electrode (indicating) that was dropped, and it can plainly be seen that the original tip of the coating is lost.

2308 An examination of this electrode, however, will show that there is a dark glassy material adhering to the end of the electrode.

This is from Exhibit 124, marked on the envelope.

Mr. Becker: Which is the end of the rod used on demonstration No. 2?

The Witness: The rod used for demonstration No. 2.

The next is Exhibit No. 125, which was for the third deposit in that demonstration.

Mr. Becker: That was the end of the rod used without Lincolnweld in demonstration No. 2.

The Witness: Without Lincolnweld, operated in the open air in demonstration No. 2. An examination of that will show a crystalline material adhering to the end of the electrode, or at least covering that portion of it.

The Court: When you refer to crystals, do you mean this darker colored portion?

The Witness: I mean this lighter colored mate-
2309 rial, around this portion here, your Honor (Indicating).

The Court: What is the darker colored portion?

The Witness: That is the oxidized metal. You will notice around the tip of the electrode here, your Honor, that the color is the same, where some of the coating has been broken off.

Mr. Wolfe: That is all.

The Court: Just a moment, Mr. Witness.

The Witness: Pardon me.

The Court: There may be some further questions. Is there cross examination?

Mr. Oberlin: If you please, your Honor.

Cross-Examination by Mr. Oberlin.

Q. Mr. Clapp, regarding the test which you made with so-called Miller flux: You made up the flux yourself for the purpose of that test, did you, or did you not use that of which a sample is here in evidence as Defendants' Exhibit 149?

A. We used melt for flux prepared by ourselves, according to the teaching of the Miller patent.

2310 Q. What was the composition of the flux as you actually made it up?

A. I do not have an analysis of it.

Q. Well, what were the ingredients of the compound?

A. Oh, the ingredients would be, as I recall it—although I do not have any notes with me—45 per cent SiO_2; 45 per cent calcium fluoride; and 10 per cent borax.

Q. What was the first compound—or the first ingredient again, please?

A. 45 per cent silica, SiO_2.
Q. And the next?
A. 45 per cent calcium fluoride.
Q. Yes?
A. And the third was 10 per cent borax.
Q. And those ingredients were fused together, were they?
A. Yes.
Q. And then granulated?
A. Check.
Q. Did you see the material comprised in this box, Defendants' Exhibit No. 149?
A. Yes, I have seen it.
Q. Did the material as you thus made it up, re-
2311 semble this—in its general appearance, I mean?
A. No, sir, the compositions are not the same.
Q. I do not refer to that. I mean, in general physical outward appearance.
A. No.
Q. How?
A. The answer is: No.
Q. Well, did it look like a crushed glass-like material?
A. Yes, sir, it was a glass before if was crushed.
Q. Do you remember the degree of fineness to which you ground it, or crushed it?
A. Approximately 100 mesh, that being the size which it is normally used commercially.
Q. And this was deposited in the form of a layer along the line to be welded, as I understand it?
A. Yes, sir, approximately one and three-quarters inches deep, as I think I said before.
Q. And the method of welding, would you say, was a normal one, that is, the one used in welding with the Unionmelt?
A. Yes, sir.
Q. And what happened to the arc, if there was one, in the operation?
2312 A. Well, the operation—
Q. Was one visible?
A. There was not complete submergence.
Q. Was there some submergence?
A. Yes.
Q. What was that?
A. There was some, but it was not continuous, and it

did not resemble the normal Unionmelt operation in that respect.

Q. But there were times when the arc was out of sight?

A. Yes—obscured.

Q. Obscured.

A. Yes.

Q. Very well.

A. But whether it was submerged or not, I could not say.

Q. Now, what was the composition which you obtained when you fused these ingredients together?

A. Presumably a sodium borosilicate.

Q. Plus calcium fluoride?

A. Yes, sir.

Q. And it did not produce a successful weld, despite your best offorts?

2313 A. No, sir.

Q. You had a metallic silicate and calcium fluoride—

A. Yes.

Q. —combined together?

A. Yes, sir.

Q. In all three of the rod end fragments which you were last discussing, the coating—and I am referring now to the refractory coating that surrounded the metal core—is intact at least to the end of the rod which was used in the welding operation; is that correct?

A. In the case of two of them it is, yes, sir, but in the third, it was broken off immediately after the demonstration.

Q. But as they were—the state in which they were when the operation was completed, was as I have stated, however, was it not?

A. Yes, sir.

Q. Actually, they projected a little beyond?

A. Yes, sir, as near as I could see. I had no opportunity to examine them at that time.

Q. Well, the two that are, as you assume, intact in this respect, do have the sheath or coating material ex-

2314 tending a trifle beyond the end of the rod that did the welding?

A. That is correct, yes, sir.

Mr. Oberlin: That is all.

Mr. Wolfe: That is all.

(Witness excused).

2315 WALTER T. FISHLEIGH, recalled as a witness on behalf of the Plaintiff in rebuttal, having been previously duly sworn, was examined and testified as follows:

Direct Examination by Mr. Wolfe.

Q. Mr. Fishleigh, have you carefully studied all of the prior art patents which the Defendants have offered in evidence in this proceeding?

A. Yes.

Q. Now, aside from the Lincoln patent, No. 1,589,017, and the Robinoff et al., patent, No. 1, 782,316, is there any other patent, or are there any other patents among all of those which they have introduced, which directs or
2316 direct the use of the powdered flux laid in a windrow along the seam to be welded?

A. No, sir.

Q. Or, putting it another way, are there any of those prior art patents, aside from the Lincoln and Robinoff patents, which disclose even so much of the process of the patent in suit, as those preliminary steps?

A. No, sir.

Q. Well, turning, then, to those two patents, that is, Lincoln and Robinoff, I call your attention, Mr. Fishleigh, to the fact that Mr. Yeomans has testified, I believe at page 2069 of the record, that in his opinion Robinoff showed the entire process which Plaintiff asserts to be infringed.

Do you agree with that opinion?

The Witness: No, sir.

By Mr. Wolfe:

Q. And I will also put the same question to you with respect to the Lincoln patent, No. 1,589,017. Would
2317 you say that it shows the entire process of the patent in suit?

A. No, sir. It lacks all of the fundamental features of the process of the patent in suit.

Q. Mr. Fishleigh, Mr. Yeomans has testified that he has observed the Lincolnweld process on two occasions at the Graver plant, and on two visits to the Lincoln Company's laboratory, each of less than half a day, and
2318 that the only time he has observed the Unionmelt process was at the demonstrations conducted before the Court.

By way of comparison, what time did you spend in studying and observing the Unionmelt and Lincoln processes?

Mr. Stewart: I object to the question, your Honor, as to how much time he has put in on this case, as being utterly immaterial.

The Court: Who brought out the time that Mr. Yeomans had spent? Was that brought out on cross examination?

Mr. Wolfe: I believe I did bring that out on cross examination, your Honor.

The Court: The objection is sustained.

Mr. Wolfe: Then, may it please the Court, my offer of proof is to show that this witness, Mr. Fishleigh, spent full days on April 17th and 18th, July 22nd, 23rd, 24th and 25th, on September 23rd, 24th, 25th and 26th, and on November 25th and 26th, in the laboratories at Niagara Falls, in work on these processes, and a half day on November 13th at the laboratory in East Chicago,—and all in
2319 addition to the inspections of the Lincoln process at Tecumseh, the Wicks Boiler Company, and the Graver plant, to which he has referred earlier in his previous testimony.

By Mr. Wolfe:

Q. Now Mr. Fishleigh, have you prepared a set of charts similar to the set, Plaintiff's Exhibit No. 204, which were previously introduced, but in this instance indicating the individual elements of the process claims, which in your opinion either do or do not find their equivalents in the Lincoln patent and in the Robinoff et al. patent which we have been mentioning?

A. Yes, sir.

Q. Now have you arranged that material on these additional charts?

A. Well, these additional charts are similar to the ones already presented, in that in the central portion I have arranged a claim block, of those claims which can be asserted as being similar.

At the left-hand side of the chart we have the identical quotations from the patent in suit, and figures represent-
ing the Unionmelt process, that much being just the
2320 same as the charts which have already been seen.

On the right-hand side of the chart, however, at the extreme right, I have photostatically reproduced either

figures or portions of the specification, or both, from the various patents cited by the Defendants.

Then, just at the right of the claim block, I have a vertical narrow column, a Yes-and-No column, similar to the one you have already seen, in which I have indicated, by yes or no, whether or not the particular element of claim is found in the particular prior art patent with which we are concerned.

Wherever a "No" has been entered, I felt that, for the convenience of all concerned, it would be well to put in an explanatory note, which explains the basis for the entry of the "No", or the two "Noes" if there should happen to be such.

2321 Since there are a number of patents cited, a couple of dozen or so, I felt that, in order to save charts; and save work, for one set of claims, instead of having a separate full chart for each one of the patents cited by the defendants, I should put in a series of flaps on one chart, so that we would have to only consider one chart for the question—or rather, in connection with the question as to whether or not, in any of the prior art patents cited, we find a complete response for the elements of the particular group of claims, each flap being for one prior art reference.

Q. Now—

A. Pardon me, but perhaps I ought to go a step further.

Q. Very well.

A. Then, at the very back end of all of these flaps, I have put a summary chart, thinking it might be convenient to see, in summary perspective the situation with respect to the entire group of patents cited.

2322 On that particular summary flap I show no specification and no figures from the individual references, but merely a yes-and-no column for each reference, showing whether or not the elements are found.

Naturally, each claim on this summary flap checks with the yes-and-no column on the individual flap, for particular reference.

Q. Have you studied the material from the publication Iron Age which has been introduced in evidence here by the defendants?

A. Yes, sir.

Q. And you have charted that item, as well, in this group, have you?

A. Yes, sir.

Q. Mr. Yeomans stated in his testimony, which I believe is to be found in the record at page 2045, that he had not tested the possibility of using the fluxes from any of the prior art patents as a substitute for the Lincoln flux, except one, allegedly made up in accordance with Miller patent No. 1,748,785.

I put the question to you: Have you participated in tests calculated to determine whether or not the fluxes recommended by the other prior art patents, pleaded in the
2323 defendants' answer, could be successfully employed as a substitute for the Lincoln flux?

The Witness: I believe I would like to hear that question repeated, please.

The Court: You will have to go back and read the entire question, Mr. Reporter.

(The question was read.)

A. Yes, I have.

By Mr. Wolfe:

Q. Approximately how many tests were conducted in carrying out that investigatory work?

A. Well, there were a great many tests, something over 170.

Q. And have you also included on the charts to which you have made reference, summaries of the results of those tests?

A. Yes, sir.

Mr. Wolfe: I offer in evidence the set of charts, your Honor, to which the witness has referred.

Mr. Oberlin: They are objected to, may it please the Court, as being purely argumentative, as in the case
2324 of the charts which were previously offered, and even more so.

These attempt to interpret the claims—or the art, the prior art, in relation to the claims, which is the particular function of this Court.

2326 The Court: Without characterizing them, the ruling will be that they are admitted subject to your examination of them. If you care to press any other objections than those that have previously been advanced to the other charts, you may do so. The admission is made without any Court determination on their characterization.

(Whereupon PLAINTIFF'S EXHIBIT NO. 236 was admitted in evidence.)

Mr. Wolfe: No further questions.

2327 Mr. Oberlin: I do not think we wish to examine the witness regarding this, since Plaintiff's counsel has not seen them and examined them, beyond having him state what their general nature is. I would like to ask the witness one question, and that is in regard to comparisons that he has made with prior fluxes, and those that are figuring in the litigation here, and particularly the Lincoln-weld flux.

Cross-Examination by Mr. Oberlin.

Q. What comparisons have you made with the Robinoff flux as actually used in the National Tube Company plant, as Mr. Robinoff testified, and other proofs here adduced would show?

2328 A. I have made similar tests and in the charts you will find one flap which covers the Robinoff flux, as I understand it was used.

Q. In other words, these charts are quite encyclopedic in their character?

A. Well, I do not know whether that is the way to talk about it. I would not use such a large word, myself.

Mr. Oberlin: Here again the witness is obviously placing his own interpfetation on this with no opportunity to examine him regarding what he understands the commercial flux thus actually used in the National Tube Company plant is like, or the process.

The Court: There is nothing before the Court on which to rule.

Mr. Byron: It is understood that in reading a chart of this kind where a witness takes a claim and details it into elements and says, "No, the prior art does not show this element and that", he is usurping the authority of the Court. That is understood, I take it.

Mr. Cahill: It is not.

2329 The Court: The evidence is not being received under any statement of condition, as I understand it, Mr. Byron.

If you want to urge any further objections before it is received, or other than those that were advanced to the other previous chart, I shall hear you. But I shall overrule you on those objections that have already been stated to the previous chart that is in evidence.

Mr. Byron: We take an exception to the ruling.

The Court: I shall give you time, if you want it, to examine this chart in order to advance any other objections or examine the witness on it.

Mr. Byron: We are not going to try to study this in a half hour, because—

The Court: I am not asking you to do that.

Mr. Byron: I understand you are not.

The Court: I am not asking you to do that, Mr. Byron. I will give you time, any reasonable time that it might
2330 take, and if the operation of adjournment enters into it, that will not be taken into consideration to the extent of asking you to examine it without time for a full examination which might be required.

Mr. Oberlin: I should like to see the precise form of order admitting the other charts. I think there was some qualification. I refer to those that were introduced in connection with the examination of this witness.

Mr. Cahill: There was none. There was no limitation.

2332 Mr. Fowler: I will first read a few extracts from the deposition of Lloyd Theodore Jones, to supplement certain extracts read by the defense.

On page 55 of that deposition, they stopped in the middle of an answer by the witness, and I would like to complete that answer.

2333 "We saw their written record of analyses of weld metal, which had been made, I believe, by Smith Emery in San Francisco. We must have seen the written record of the analysis of flux which they had obtained somewhere. I don't remember any other data which they had or which they made available or which they told us about."

That completes that answer.

Then on page 74, starting near the top of the page:

"A. The visits we made from May on in '32 were not concerned with or an inspection of the welding which they were doing with the so-called Robinoff and National Tube process.

"Q. Very well. What were they concerned with?

"A. They were concerned with our own effort to produce a weld which had already departed from the Robinoff and National Tube processes.

"Q. But my question is, just what did you do when you went there on those visits?

2334 "A. In general we would take with us the ingredients for a flux to be fused and with which we hoped to be successful and over there would fuse and then pulverize the flux, prepare sample plates to be welded, and then carry out the welding; thereafter making such tests as for porosity, bend tests and breakage tests, as would be necessary to determine the success of that particular weld.

"Q. You brought ingredients for this flux with you to the plant on those occasions, do I understand?

"A. I think on every single occasion we supplied and took over with us the ingredients for the flux.

"Q. Then you spoke of fusing those ingredients. You did that in the plant?

"A. I think in every single case except one we fused the ingredients at their plant.

"Q. What facilities did they have for that operation?

2335 "A. For that they had borrowed—let me change my wording. For the fusing of the flux for us they had borrowed a brass-melting furnace some two feet or so in diameter and six feet long, which could be oil-fired and in which we hoped to be able to melt the material, even though its melting point approached that of steel.

"Q. Now, did you obtain for the purpose of compounding the flux any of these ingredients from stocks which Western Pipe had on hand?

"A. I think never on any occasion did we ever procure even a single ingredient from Western Pipe and Steel or their stock, except that we may once have scraped up some iron oxide from near the rolls, where they had been rolling plate."

And then a short extract from the deposition of James Keir, to supplement what counsel for the defense read. Starting at the bottom of page 198:

"Q. By the way, one of the products which the Unionmelt Division, I believe, supplies customers is weld rod. Do you know who makes that weld rod for the Sys-

2336 tem, which division or unit?

"A. You mean the rod that is made for the Unionmelt purpose?

"Mr. Wolfe: You need not answer as to the name of any outside supplier.

"Q. I assumed it is made by one of the subsidiaries by the question as asked.

"A. No. It is made by an independent steel company.

"Q. Has Linde or any of its associated companies in the System ever made the weld rod or metallic electrode used by Unionmelt?

"A. Not to my knowledge. I am sure there has been none ever made that way."

2337 Then just one question and answer from the deposition of J. B. Quigley, at page 32:

"Q. What is the source of all of the flux that you used in this Lincolnweld process?

"A. The Lincoln Electric Company."

Mr. Quigley, your Honor, of course, was working for the Graver Tank & Manufacturing Company.

2340 Mr. Wolfe: I would like to take care of just one
2341 small matter on the record, if the Court please.

This series of X-rays of the plates made at the demonstrations was introduced this morning as, I believe, Plaintiff's Exhibit 231; and I thought it would facilitate their identification if I change that number designation to make it the same as the number for the plate of which the X-ray is taken, with the addition of the letter "X", because those numbers appear on the films themselves,—182-X, and so on.

Is that satisfactory?

Mr. Stewart: We would like to do the same thing with ours.

2342 The Court: Well, do you have any objection to Mr. Stewart's statement?

Mr. Wolfe: Not at all.

The Court: Very well, that may be done.

HARRY EDWARD KENNEDY, called as a witness on behalf of the plaintiff, having been previously sworn, was examined further and testified as follows:

Direct Examination by Mr. Wolfe.

Q. Did you ever make a weld, Mr. Kennedy, with a copper silicate flux?

A. I did.

2343 Q. On what metal?

A. On bronze.

Q. What was the character of the welding action?

A. It was perfectly normal. We used copper silicate

because we knew that bronze was a mixture of copper and tin, and obviously copper silicate would not be harmful to the metal.

We were also aware of the fact that copper was very deleterious to steel, because in our welding operations we frequently picked up copper from the chill bar and this always resulted in cracking of the weld metal.

Mr. Wolfe: That is all.

(Witness excused.)

2344 Mr. Oberlin: If your Honor please, the question that was left open at the time of adjournment last evening was with regard to the admissibility of these charts.

Touching that question we should like to have our 2345 colleague, Mr. Bomberger, address the Court briefly.

We were given permission, your Honor will recall, to state any further objections that we might have to the charts, when Court convened this morning.

It was our understanding that the ruling was reserved.

Mr. Bomberger: If your Honor please, if I may be heard.

The Court: Mr. Bomberger.

Mr. Bomberger: I wish to speak only very briefly. When this exhibit was offered it seemed to me to be objectionable, and upon further examination of it, I am still further convinced that my first impressions with regard to it were correct.

These charts are abounding in independent evidence, not merely explanatory of the testimony of this witness; and they therefore in my opinion come within the rule which provides that legends and writings of various kinds on maps or plats, which state the conclusions of the witness, or the opinion of the witness, render such maps and plats inadmissible.

2346 I think that, under the authority which we find assembled in 108 ALR, page 1415, this character of evidence clearly falls within the inhibition of the rule.

Mr. Cahill: May it please the Court.

The Court: Mr. Cahill.

Mr. Cahill: With all due respect to ALR, your Honor, let me observe that the law has progressed to a very large degree in recent years with regard to such exhibits as we have here.

For example, the exhibits of the Federal Bureau of In-

vestigation in Criminal Cases today, are all bound up in a form similar to this, and contain compilations, and the opinions of experts.

I want to mention again at this time my total disagreement with the idea of counsel, that there is something about a conclusion which is prohibited, in the testimony of an expert witness. I am in total disagreement with that theory, because, to my mind, an opinion by hypothesis is a form of conclusion, and that is just exactly what
2347 the Court invites when it allows expert testimony in any form, because I think any opinion is tantamount to a conclusion, and what the Court is seeking is the operation of the mind of the person skilled in the art, as an aid to the Court in making up its own mind.

I think that that was what this Court had in mind when it overruled my objection to certain of the questions that were propounded by counsel for the Defendants, to their witness, Mr. Yeomans.

As your Honor said at that time, there has to be somebody who brought this material together for the Court and gave the Court such aid and assistance as the Court might need in collecting the material necessary for consideration of this matter.

Now, in principle this is the same kind of material as was produced through the witness Yeomans. In volume it is much greater, but the reason for the increase in volume lies only in the fact that these Defendants have
2348 seen fit to plead an extraordinarily large number of patents. Because they have done so, that requires that we meet the issues laid down in the unusually large number of patents they pleaded, running into a large volume; and that is the only reason for the number that we are offering at this time.

Mr. Oberlin: We invite the ruling, your Honor.

The Court: In ruling, I will say that I have no further facts on this, I think, than I had at the time of the previous offer of similar exhibits.

It seems to me that two reasons for the range of admissibility or the range of reasons for exclusion are not present: One, it is a trial before the Court. There are conclusions that border on ultimate conclusions of fact or conclusions of law. They can be weeded out, since they are brought to the Court's attention by counsel, in their briefs or arguments.

2349 Secondly, in this phase of the case, expert testimony may be of a conclusionary nature. That is not only permissible but it may aid the Court in arriving at its decision.

For those reasons and the other reasons stated in the previous ruling, the objections are overruled and the exhibits admitted.

(Whereupon PLAINTIFF'S EXHIBIT No. 236 was admitted in evidence.)

Mr. Oberlin: I call Mr. Fishleigh for further cross-examination.

WALTER T. FISHLEIGH, recalled as a witness on behalf of the Plaintiffs in rebuttal, having been previously duly sworn resumed the stand and testified further as follows:

Cross-examination (Continued) by Mr. Oberlin.

Q. Mr. Fishleigh, the designing and preparation of these charts, Plaintiff's Exhibit 236, represents a considerable amount of labor on your part and that of your associates, does it not?

A. Particularly on my part, because the preparation of these charts, except for consultation and advice, 2350 was not anticipated in by my associates.

Q. But it required a considerable effort and amount of labor on your part, did it?

A. Yes, a great deal.

Q. And that was not, I take it, a labor of love, Mr. Fishleigh?

A. Well, I wouldn't care to use exactly that word. I get paid for my services, if that is what you would like to know.

Q. When were these charts which comprise this exhibit completed, Mr. Fishleigh?

A. Well, the bulk of them were completed a month ago. Some were completed since we have been here.

2351 Q. Which ones were completed since we have been here?

A. The charts which have to do with the Strohmenger patent, 1,041,525, the Armstrong patent, 1,241,899, the Armor patent, 1,467,825, and the last Miller patent, 1,754,566.

Q. All the others were completed before the beginning of this hearing?

A. Yes. That is correct. That is, it depends a little bit, Mr. Oberlin, on what you mean by "completed". If you mean the photostating and all completed, the answer is no.

Q. I refer, of course, to the original drawings, not to the duplication of them in the form in which they have been presented to the Court here and to counsel.

A. Yes. They were all completed before we came over to the trial.

Q. Except the four which you have just enumerated?

A. That is correct.

Q. Now, included among the others are representations in chart form and otherwise of your evaluation of the National Tube Company method or process of welding?

2352 A. Yes, sir.

Q. That chart was prepared before any evidence touching the same was presented to this Court—

A. Well, I think—

Q. —is that correct?

A. I am not sure.

Q. That chart was completed, you said, before this trial began?

A. Yes.

Q. All right. Then that chart is not based on any evidence presented here?

A. It is now, yes, sir, because the evidence presented here checked with what I had, the information that I previously had and that I had previously gained from Mr. Robinoff's depositions.

Q. But that deposition is not here in evidence, is it?

A. I don't know.

2353 Q. Well, actually, the only reference to any proofs regarding what was done at the National Tube Company, in the way of electric welding, is that found in the Iron Age Article which is an exhibit in this case; is that correct?

Mr. Cahill: I object to that question also, your Honor, as constituting an argument by counsel with the witness as to what are proofs.

The Court: You are not asking him what is in the case, as I understand the question, but as to what he has in mind, as to the proofs; is that correct?

Mr. Oberlin: Yes.

Mr. Cahill: So long as it is made plain that this
2354 is not an attempt to get back to what is in the record, your Honor, I will withdraw my objection.

The Court: All right. You may answer the question.

The Witness: I would like to hear the question again, if you do not mind.

Mr. Oberlin: Read the question, please.

(The question was read.)

A. No, that is not correct.

By Mr. Oberlin:

Q. Well, what else does your chart show, then, the one relating to the National Tube Company operation?

The Court: Which one?

By Mr. Oberlin:

Q. (Continuing) And will you identify the chart referred to in this portfolio?

2355 The Witness: If you will look at your chart No. 23, your Honor—that is the one that I happen to have before me here; if you will look at chart No. 23, Mr. Oberlin, which happens to be the chart that I have before me, and if you will look at the last flap, the bottom flap of that chart, you will see there a reference to the National Tube Company practice, and you will also see, at the bottom, on the bottom flap, an analysis of Lower Kittaning No. 3 clay, unslaked lime, and ferromanganese, and the percentages, which are the percentages which were given here in court by Mr. Robinoff, if I remember correctly.

By Mr. Oberlin:

Q. When you said "the last flap"—

A. And also—

Q. Pardon me. Go ahead.

2356 A. (Continuing) And also, on that same sheet, you will see photostated a description of the process, and the flux used at the Western Pipe & Steel Company, which is in evidence, and which I understand from the evidence is substantially the same as was used at the National Tube Company.

Q. When you said "the last flap" you did not mean the very last one, I take it, because that seems to be a summary of "Noes", with some few "Yeses".

A. Yes, sir, that is correct. I did not mean the summary chart, of course, on the summary flap.

Q. Well, the preceding flap in the chart which you referred to, is captioned "Iron Age—Prior Publication", and the article, with a cut included in it, is at least in part reproduced on this flap, along with your comments thereon: that is correct, is it not?

A. That is true, yes, sir. That flap covers the Iron Age article.

Mr. Wolfe: Pardon me just a moment, please, Counsel. Let me see that.

Mr. Oberlin: Yes.

By Mr. Oberlin:

Q. Had you ever seen a weld produced at, or in
2357 the course of this National Tube Company operation of electric welding of pipe; before the trial began?

A. Pardon me; do you mean, at the National Tube Company?

Q. One produced there.

A. One produced at the National Tube Company before the trial began?

Q. Had you ever seen such a weld before the beginning of this trial?

Mr. Cahill: Are you asking now for the knowledge of the witness, as to one that he knows personally was made at the National Tube Company?

Mr. Oberlin: Yes.

A. If I did, I do not recall it.

By Mr. Oberlin:

Q. You never saw the operation in progress there, of course, did you?

A. At National Tube?

Q. Yes.

A. No, sir.

Q. Mr. Fishleigh, you will recall being retained by the defendant in a case brought some years ago in this
2358 court, the Northern District of Indiana, I believe at the South Bend Division; entitled Wayne Company, plaintiff, *vs.* Anchor Oil Company and Milwaukee Pump & Tank Works, Inc.?

Mr. Cahill: I object to this as not being within the scope of the direct and improper rebuttal.

The Court: It is preliminary. I do not know what counsel

has in mind. I will overrule the objection to this particular question.

A. I recall being retained in a case with that title. I did not associate the present defendant with that case.

Mr. Oberlin: I am not asking you to.

By Mr. Oberlin:

Q. Did you prepare an affidavit for use—

A. Just a minute. You asked me if I recall being retained by the defendant?

Q. In that case, one or the other of the defendants, the two named.

A. Then my answer is no, because I do not recall the defendant as being connected with it. I do recall
2359 very definitely—

Q. I am not speaking about this defendant, Mr. Fishleigh. I mean the defendant in that case retained you, one or the other of the two.

A. Oh, yes. My answer is yes.

Mr. Oberlin: I thought my question was explicit. I did not mean to confuse you, sir.

By Mr. Oberlin:

Q. In connection with the service you rendered in that case, you prepared a rather elaborate affidavit at one stage in the proceedings for use?

Mr. Cahill: I am sorry to keep interrupting, but I must renew my objection to each question of this line as being improper rebuttal and not within the scope of the direct.

Mr. Oberlin: These questions are going to the qualifications of the witness, your Honor, especially in connection with charts such as he has presented here as Exhibit 236.

Mr. Cahill: The witness was examined on the case in chief. Defendants had the opportunity to cross-
2360 examine and they did not ask a single question.

I submit they waived whatever right they had to go into his qualifications at that time.

Mr. Oberlin: We did not have any such charts as these, and the questions I am asking are directed to the witness's qualifications to present testimony in the form in which it is being presented by this exhibit.

Mr. Cahill: The charts were precisely the same.

The Court: Just a minute, please. You are objecting because they did not see fit to ask these questions at the

first opportunity they had for cross-examination? Do I understand your objection correctly?

Mr. Cahill: That is part of my argument. The ground for my legal objection is that we are now in the rebuttal case, that we have been confined to what is rebuttal on the objection of the defendants, and I say that the rule works as to them as well; that this is improper rebuttal;
2361 and that the question is not within the scope of the direct examination on rebuttal.

In furtherance of my argument I point out that this is not a witness who is sworn for the first time on rebuttal, but he was sworn on our case in chief, and that exactly that same type of evidence was proffered at that time.

In furtherance of my argument I call your attention to the fact that the defendants did not ask a single solitary question.

The Court: I will hear you in response, Mr. Oberlin.

Mr. Oberlin: May I state first of all that what I am asking the witness about is a matter that has come to our attention just last evening. I did not have this information in my possession at the time the witness was on the stand during plaintiff's original presentation.

In the second place, as I have remarked already, we are confronted here with an extraordinary exhibit.
2362 I have never seen anything like it in any patent case, even.

With regard to the witness's qualifications to prepare such a chart, these questions I am asking are directed, irrespective of whether they would have been appropriate even during his examination before, to the testimony this witness has given in plaintiff's rebuttal.

The Court: Other than the question of the fact you did not have the information on which to base your questions until now—your statement to that effect—would you not ordinarily be precluded from asking at this time questions which were within the scope of cross examination at the time this witness was on previously?

In other words, the witness testifies as to his qualifications to testify as an expert, and then he testifies on that subject as well as other matters. He is turned over to you—

Mr. Oberlin: And we do not cross examine him.

The Court: —and you do not cross examine him
2363 on that. Then later he is offered as a rebuttal witness and he does not testify on that particular point

because he has already testified previously. Then you attempt to cross examine him on a matter which he had gone into on direct.

Now, are you not precluded, as I say, leaving aside the question of information which you did not have, from going into that at this time?

2364 Mr. Oberlin: I think not, because, as I stated secondly in my remarks, it is in connection with an exhibit just now, in rebuttal, offered in evidence that I am interrogating the witness.

The Court: In the first place, aren't the exhibits of a similar nature and the examination the same type of examination?

Mr. Oberlin: These relate to the validity of patents. They relate to the evaluation of prior art, whether as presented in Court or derived from other sources.

The Court: As to his qualification, whether it relates to prior art or evaluation or an explanation of the patent in suit, his qualifications on that are the same, aren't they?

Mr. Oberlin: Not when the evidence is presented in this form. It is to the form of the presentation as to the qualifications of the witness or to present the matter in this form, that the questions are directed.

Mr. Cahill: I submit they are identical; the questions are identical.

2365 The Court: Ordinarily I would think that you had *waived* your opportunity to cross examine. It may be within the discretion of the Court to let this in, if it is pertinent.

Mr. Oberlin: I shall content myself by citing the opinion of the Honorable Judge Slick of this Court, in the case to which I referred, and not cross examine the witness further, if I may, your Honor.

Mr. Cahill: May I point this out; Yesterday we had the Witness Clapp on the stand, and we hadn't been in possession of the evidence as to barium and strontium until we rested our case in chief.

We urged that we should be permitted to go into that, and notwithstanding that we had not had that evidence in our possession at the time we closed our case in chief, the Defendants objected and the objection was sustained.

Mr. Oberlin: That was on another ground.

Mr. Cahill: We had not had the evidence until we rested our case in chief.

2366 Mr. Oberlin: The objection was on another ground.

Mr. Cahill: I submit there is a parallel there that should bind these Defendants in this instance.

The Court: It seems to me—I don't know whether Mr. Fishleigh was the last witness or not.

Mr. Cahill: He was, as I recall.

The Court: How much prior knowledge did you have of the fact that he was going to be a witness, before he actually took the stand?

Mr. Oberlin: We saw him in the Court Room, your Honor, and assumed, knowing that has been his frequent participation as an expert, that he would be a witness.

We may even have been informed by Plaintiff's counsel. The assumption was he was going to testify as an expert.

Mr. Cahill: As I recall, they had, over the week-end, his charts, and saw him as far back as last May at the Graver plant.

Mr. Oberlin: Over this week-end?

2367 Mr. Cahill: As I recall, he went on the witness stand a week ago Friday.

The Court: It seems to me the orderly procedure, unless there is some evidence which ought to be brought before the Court that was unavailable, or not known at that time, that counsel should be bound by the rules of evidence that ought to be invoked.

The only exception would be if there was some exceptional situation where evidence only came to your notice and could only have been known at a late stage of the trial, and for that reason the rules that would ordinarily apply would be abrogated.

It seems to me that you having known, having had some intimation that this witness was going to be offered, this present witness, and as an expert, that you should have availed yourself of the opportunity of cross examining him on this point at the time when that was a part of the scope of your cross examination.

Mr. Oberlin: Your Honor, I don't want to detain the Court with a further argument on this matter. The

2368 witness has identified himself with having participated in what I questioned him about in the case.

The only other matter I have to call to the attention of the Court is this one decision, and I will content myself with that.

I refer to the opinion of the Honorable Judge Slick.

Mr. Cahill: I object, may it please the Court. With all due respect to Judge Slick, this is merely an attempt, now, in another fashion, to get something before the Court which ought to have been raised otherwise, in orderly fashion.

There is no showing of any surprise here, there is no showing of any relevancy. This is merely an attempt to cite an opinion containing facts which have been ruled out, as I understand the ruling of your Honor here today, or at least, not pressed by counsel.

It is merely an attempt to circumvent the ruling of this Court.

The Court: Are you not now trying to point out the legal determination of a fact as to which I have ruled
2369 that you are precluded?

Mr. Cahill: Precisely.

Mr. Oberlin: I am modifying my approach to the matter to this extent, your Honor, that, with the witness himself present, and with counsel to guide him, I am citing to the attention of the Court a case which I should have the right to cite, an opinion of a Court which I should have the right to cite in argument, even.

The Court: With respect to what? With respect to a question of law, with respect to a question of fact?

Mr. Oberlin: I would say with respect to both, your Honor.

Mr. Cahill: I disagree.

Mr. Oberlin: (Continuing.) On the qualifications of the witness to give the kind of testimony that is embodied in this exhibit that we have before us here.

Mr. Cahill: We are not bound by a determination of fact in a case to which we were not a party, and par-
2370 ticularly when it deals with a matter with regard to which the Court has just expressed himself as he has.

The Court: Well, it seems to me that a decision upon a question of fact is just as infirm as would be direct questions put to this witness. I mean, for the Court to be consistent, I do not know that that character of material should make it any more admissible, just because it happens to be contained in a law book instead of in an affidavit.

Mr. Oberlin: We are not relying on any determination of fact or law found in this case, your Honor. I was merely stating the character of information to be found therein.

We shall rely only on the qualifications of the ruling, as to evidence of this character; and I am content to let the matter rest there.

The Court: There is no legal question before me at the moment, but as far as any other case may bear on any legal phase of this case, there is of course no preclusion of
2371 counsel citing such case, or other cases, or questions of law.

Mr. Oberlin: Or opinions.

The Court: (Continuing) But as far as questions of fact are concerned, I doubt very much if that would be proper.

Mr. Oberlin: We shall feel free, then, as I say, to cite this opinion to the attention of the Court as bearing on the competency of evidence such as indicated by these charts.

With that, I have no further cross-examination.

The Court: Is there anything further with this witness?

Mr. Wolfe: No further questions, your Honor.

(Witness excused.)

Mr. Cahill: The Plaintiff rests its case in rebuttal, your Honor.

And thereupon the Plaintiff, by its counsel, then and there rested its case in rebuttal.

2372 Whereupon the Defendants, to further maintain the issues in their behalf, by their counsel, offered the following evidence in surrebuttal, to-wit:

Mr. Stewart: Dr. Nusbaum, will you take the stand, please.

CHRISTIAN NUSBAUM, recalled as a witness in surrebuttal on behalf of the Defendants, having been previously duly sworn, was examined and testified further as follows:

2373 *Direct Examination by Mr. Stewart.*

Q. Dr. Nusbaum, as a part of the testimony here yesterday put on by the plaintiff, there was the offer of five X-ray plates, contained in envelopes, bearing the numbers respectively of Plaintiff's Exhibits 229-A through 229-E, which were identified as being the X-ray plates, or the X-ray films, which you made of welding operations taking place with the use of a clay flux.

Now, among those there is one plate designated as Film No. VIII-R—that is, a Roman numeral—and that plate or film does not have any counterpart in the other films, the other pictures, taken using the Lincoln flux.

In other words, there is no plate marked Roman numeral VIII, already in evidence as a part of your direct testimony; and I would therefore like to have you explain to the Court just what that plate No. VIII is, since there are no data in connection with the Lincoln flux welding operations to which that could be related.

Mr. Cahill: This is something of the witness's own
2374 personal knowledge, now, I take it, is it?

Mr. Stewart: Oh yes.

A. That was taken with the open arc and flux interposed between the target of the X-ray tube and the arc itself.

The arc was not surrounded by the flux.

By Mr. Stewart:

Q. Handing you Defendants Exhibit 119, can you more clearly explain that?

A. Instead of the flux surrounding, as here indicated, we had an open arc, but the flux was interposed between the X-ray tube, which is out here (indicating), and the arc itself.

In other words, the flux was in this position (indicating), in a container, so that the X-ray beam passed first through the flux, and then through the open arc.

Q. And there was no such comparable film of the welding operations using Lincoln flux superimposed, was there?

A. Yes, there was.

Q. I do not think it was introduced, Doctor.

A. No, sir, it was not introduced, however.

2375 Q. That was the only difference.

A. This one was not intended to be introduced, either, because it has no bearing on the case.

Mr. Cahill: I will move to strike out that last observation of the Doctor.

The Court: The last statement is stricken.

Mr. Cahill: With respect to a bearing on the case.

The Court: The last statement, with respect to bearing on the case, is stricken.

Mr. Stewart: It is only submitted, your Honor, to clarify that one film, because there are no data attached to it. The others were all related to the other films.

By Mr. Stewart:

Q. Now, Dr. Nusbaum, yesterday there was introduced as Plaintiff's Exhibit No. 230, which purports to be a photostat of an article by L. L. Holladay, entitled Resistivity of Vitreous Materials, and Dr. Doan testified that there was a statement in there relating to Maxwell's Law of Distribution of Molecular Velocities, and a paragraph on that
2376 which bore on your testimony relating to the application of that law to fused salts and ionized gases.

Calling your attention now, Dr. Nusbaum, to page 231 of this article, the paragraph toward the bottom of the page, will you first please explain what Maxwell's Law of Distribution of Molecular Velocities is, and to what it is normally applied.

A. Maxwell's Law of Distribution of Molecular Velocities refers to a gas or vapor, primarily, and it refers to the random distribution of velocities of the molecules in their random motion.

I can illustrate this way: if we take a given volume of air, for instance, a cubic centimeter, and if we could at any given instant determine the velocity of all the molecules in that given volume, they would follow a definite law which can be illustrated by this simple curve (indicating) and is generally known as the Maxwellian Distribution.

We plot velocities in this direction (indicating)—

Q. That is, horizontally?

A. Horizontally, along this axis—and the number in this direction (indicating).

2377 Q. Vertically?

A. Vertically. The distribution of velocities would be given by a curve somewhat of that shape (indicating). This Maxwell velocity is what is known as the most probable velocity.

If we take a small area here, that area would represent a number of molecules which have what we call the most probable velocity. This number here (indicating) would refer to the percentage of all the molecules in that cubic centimeter that lie within these two velocity limits; that is, a velocity which is equal to V, plus a velocity which is equal to V plus some small quantity, such as delta V. In other words, within this limit (indicating).

That means that not any of the molecules really have a zero velocity. The maximum number have the most probable velocity. There are a certain number of molecules

which have a velocity which is twice as great as the most probable, and there are, again, a certain number, exceedingly small perhaps, one molecule out of a billion billion molecules, or even more—even a smaller number, I
2378 mean—which have a velocity which is twice as great.

These molecules may move sufficiently fast to occasionally produce a collision. That is, they may hit another molecule, is what I mean by that, because they may come close to each other, sufficiently close to each other so that one of the atoms will lose an electron, and if that is the case that atom which has lost the electron is said to be ionized. This is ionization by collision.

I might say, however, that the Maxwell distribution refers only to the random motion of the atoms or molecules and does not refer to any motion such as is brought on by the application of an electric field.

Q. Now, calling your attention to page 231 of Plaintiff's Exhibit 230, there appears this statement:

"An explanation of our observed results may probably be most simply found by employing Maxwell's Law of Distribution of Molecular Velocities. Since glass is an amorphous substance with presumably no cyrstalline structure, free electrons would probably encounter about the
2379 same kind of resistance to their movement that they do in an ordinary gas."

What would that mean to you, about the kind of resistance to their movement?

A. The resistance is very likely of the same nature, but of an entirely different order of magnitude, as the opposition to motion. The opposition to motion in a glass would be infinitely smaller—or rather, larger in magnitude than the opposition to motion in the case of a gas.

That is due to the fact that the velocity of a fused salt is generally a definitely integral value, that is, the number of molecules per unit of volume, so the electron will encounter much opposition—or the ions and the electrons, both the ions and the electrons will encounter much opposition in their movement, even though an electric field is applied.

In the case of a gas the number of atoms per unit of volume is many times smaller, and therefore the opposition to the motion of electrons or ions is infinitely less, many thousands of times less.

2380 Q. Now, that resistance, the word "resistance" there, is resistance to their movement and not what we term electrical resistance?

A. That is right. It is an element in electrical resistance, but it is primarily what we mean by the opposition to their motion.

In the first place, the motion of electrons and ions in the case of an amorphous substance or crystalline substance, the motion is exceedingly small.

In the case of a gas, the motion of an electron may be billions of centimeters per second, instead of a few centimeters per second, as in the case you saw.

Q. Can you illustrate by some known measurements as between the movement of an ion in an electrolyte, an ion such as the hydrogen ion in the electrolyte, and the movement of an ion in an electric arc, per volt?

A. The mobility—and that is the distance it moves in centimeters per second for the unit potential applied of one volt—for the hydrogen ion is from 5 to 7 centimeters per second.

Q. For one volt?

A. For one volt.

2381 An electron volt, which gives us the velocity of an election in a vapor, can readily be shown to be 60,000,000 centimeters per second for one volt, a difference of 60,000,000 per second, and a difference of potential of 30 volts.

That would increase the velocity from 60,000,000 to 360,000,000 centimeters per second. That is the maximum permissible velocity obtainable by an electron in an electric field, and comes from the universally accepted expression of the potential applied, and the charge on the electron is equal to ½ Mv squared. v minor is the velocity of the electron; and V major is the potential applied in volts.

If V major is one volt, we know the charge on the electron; we know the mass on the electron; we can calculate, therefore, its maximum permissible velocity in an electric field of one volt, and this expression comes out 60,000,000 centimeters per second.

Q. Now, Dr. Nusbaum,—

A. Just a second.

Q. All right.

A. (Continued) An electron moving with such tremendous velocity, when it collides with an atom or
2382 molecule in this electric field does produce ionization by collision.

However, the electrons moving in an electrolyte have such low velocity they do not, and cannot, produce ionization by collision. Their energy is not adequate.

Q. One further question: Maxwell's Law of Distribution of Molecular Velocity, I believe you said, applied to the random motion of the particles.

A. That is correct.

Q. In gas or if you want to apply it to a fluid. When you apply it to the electric field, that is not random motion?

A. It superimposes on that random motion a motion force much large in magnitude, set up by the electric field, a much larger order or magnitude.

Mr. Stewart: That is all.

Mr. Cahill: May we have just a moment.

(Short interruption:)

Mr. Cahill: No cross.

2383 Mr. Oberlin: There is a reserved ruling in connection with the Lincoln-Cornwell correspondence, your Honor, Defendants' Exhibit 104, which I think has not been cleared up.

Mr. Cahill: There was no reservation. That was ruled on; your Honor excluded that. We argued that extensively.

Mr. Oberlin: We were given an opportunity to select or condense that correspondence, is my recollection.

Mr. Cahill: I see nothing by way of selection or condensation.

Mr. Oberlin: I am coming to that. In that connection, we will offer, in addition to what the Plaintiff put in, the preceding letter from Mr. Lincoln to Mr. Cornwell,

2384 dated July 31, 1931, the same being Plaintiff's Exhibit 12 for identification in the Lincoln Deposition taken in Cleveland last January, as I remember it.

Mr. Cahill: That I would object to on the ground I urged before, that it is a self-serving declaration by the Witness Lincoln.

The Court: Has there been anything occurred since the previous ruling which would meet the onus of the objection?

Mr. Oberlin: I think I can show that, your Honor. It is a notice to the Plaintiff, to Mr. Cornwell, of the infringement of the John C. Lincoln Patent. There is nothing self-serving about it whatever.

Mr. Cahill: I think that is entirely self-serving, a

notice by Mr. Lincoln of an infringement of some other patent. There could be nothing but a self-serving declaration in that. You can't make evidence of that kind.

Mr. Oberlin: It certainly explains the evidence put in by Plaintiff, in which there was a cross-license under discussion.

2385 Mr. Cahill: I submit it doesn't in any way explain it. It is entirely self-serving. Nobody can make evidence by things of this kind. The rule as to self-serving declarations was directed at this sort of thing.

The Court: If it tends to explain other correspondence,—

Mr. Cahill: If it did, I would go along with it.

The Court: They say it does. I can't determine that until it is in.

2386 Mr. Cahill: This is entirely self-serving, a claim by this man as to an infringement by Linde of another patent.

Now, that doesn't have the slightest bearing on the admission that we forced out of Mr. Lincoln, when he denied that he asked for a license under our patent and we taxed him, on cross-examination, with a letter enclosing the license agreement. It has no bearing whatever on that.

The Court: If it is admissible, what prejudice or harm can there be in letting it in?

Mr. Cahill: Well, once we start—

Mr. Oberlin: May I be heard a minute?

Mr. Cahill: When I finish.

The Court: I asked him a question.

Mr. Oberlin: I beg your pardon.

Mr. Cahill: Once we allow material to go in which is self-serving in its nature, we have let the bars down on the laws of evidence; and once we do that, there is no telling where we will stop.

Now, this is a claim as to which possibly Mr. Lin-
2387 coln could have been queried by these counsel when he was on the stand. This isn't a case of an absent witness. This is a case of a man who was examined by counsel on direct, at length.

Now it is sought, in surrebuttal, or it was sought in the case in chief—I don't press that point, because it was brought up earlier—it is sought to present this, and it is entirely a self-serving declaration. I submit it could not be anything else.

Mr. Oberlin: We submit that this is in rebuttal of the

document which is in evidence in the form of the document attached as a cross license, which they contend shows the seeking of a license.

The document on its face negatives any such assumption on the part of counsel, by the fact that by these letters the negotiations, which included the other letters, were initiated, and this contained a charge of infringement of the John C. Lincoln patent, and is directed to the Linde Company and is, I think, essential to the entire
2388 matter.

The Court: How far do you seek to pursue it?

Mr. Oberlin: This is the only one of the whole series I am offering.

The Court: Objection overruled.

Mr. Oberlin: The original attached to the deposition should be the one used. I have merely a carbon copy here.

Mr. Becker: Are you offering that as 158, Mr. Oberlin, or part of 104?

Mr. Oberlin: I will offer it as part of 104—or it will be 104, limited to this one letter, that of July 31, 1941, from the Lincoln Electric Company, by James F. Lincoln, president, to Mr. Cornwell.

The Court: Will you detach it from the others?

Mr. Oberlin: Yes, your Honor; and we will give it to the Clerk to be identified as an exhibit.

It will be 104-A, your Honor. The others comprising Exhibit 104 are ruled out, as I understand.

2389 (Whereupon the said letter referred to was marked DEFENDANTS' EXHIBIT 104-A and admitted in evidence.)

Mr. Oberlin: There were identified two welds produced by the witness Robinoff, as Defendants' Exhibits 106 and 107, which we now offer in evidence.

2391 Mr. Oberlin: The question was on the admission of Defendants' Exhibits Nos. 106 and 107, your Honor, and there is no objection, as I understand it.

Mr. Cahill: No objection.

The Court: Very well. They are admitted.

(Whereupon said DEFENDANTS' EXHIBITS 106 and 107 were admitted in evidence.)

Mr. Oberlin: I would also like to have it a matter of record, that it is understood and agreed by counsel
2392 that the contents of the box which has been marked as Defendants' Exhibit No. 116, the contents being certain metal parts marked as Defendants' Exhibits 116-A to 116-E, likewise have been offered and admitted.

Mr. Cahill: That is agreed.

(Thereupon said DEFENDANTS' EXHIBITS 116-A to 116-E, both inclusive, were admitted in evidence.)

Mr. Oberlin: We also have a few remaining exhibits, your Honor, which were accumulated in connection with the demonstrations given on January the 15th, which Mr. Stewart will identify and offer; and also possibly some other items, in the way of parts.

Mr. Stewart: I do not recall, your Honor, whether the actual plates which were welded in the defendants' demonstrations, were definitely offered and received in evidence, or not. They were identified as Defendants' Exhibits Nos. 123, 126, 128 and 131.

2393 I offer those plates in evidence at this time, and also the X-ray films bearing the same exhibit numbers, but with the letter X after each one, as being the films taken of each of those plates.

Mr. Wolfe: No objection.

The Court: Admitted.

Mr. Becker: Those plates have been admitted.

Mr. Cahill: I am advised that the plates have been admitted, your Honor.

The Court: I did not hear.

Mr. Cahill: I say, Mr. Becker informs me that the plates have been admitted.

Mr. Stewart: Well, I said that I was not sure.

Mr. Cahill: Mr. Stewart did say that he was not sure, but they have been.

Mr. Stewart: And are we agreed that the other items that were used, that is, pieces of rod, flux and so forth, which were identified during the demonstrations, have also been offered and admitted?

Mr. Cahill: Agreed.

2394 Mr. Stewart: Now, we do not have any desire to put in those plates relating to your exhibits, 229-A through 229-E, those X-ray pictures of the welds made.

Mr. Wolfe: No.

Mr. Stewart: We do not care about that, either.

I believe that is all there is relating to the demonstrations, your Honor.

The Court: Do I understand, then, that both parties now rest?

Mr. Stewart: The defendants rest.

41 PLAINTIFF'S EXHIBIT NO. 128.

December 5th, 1931.

Mr. H. H. Lester,
War Department,
Watertown Arsenal,
Watertown, Mass.

Dear Sir:—

I have forwarded to you by express a box containing fourteen samples of our automatic electric weld, ten of which are from 1/4 plate.

We are particularly concerned at this time about the worm holes that show to a certain extent in all of the samples, with the possible exception of 1, and which are more apparent in the heavier welds than in the lighter.

We began in March of this year, in our Los Angeles plant, welding on a 1/4" thick pipe, 26 in. diameter, using welding units very similar to those installed in the National Tube's plant at Pittsburgh, which, in case you are not familiar with the system, derived the current from a General Electric, 3 Unit, Synchronous Motor Generator Set, consisting of the following:

1 G. E. Type TS, 6 Pole, 120 HP, Unity Power Factor, 3 Phase, 60 Cycle, 97 KVA, 440 Volts, Synchronous Motor arranged, for 230 volts, excitation direct connected to and mounted on a common base, with 2 CD-36 KW, 4 pole, 45 volts, Differential Compounded Direct Current Generator with Generator Panel, Mounting Knife Plate Switches for control of grid shunts of the series field. These generators are also known as Type YW, 800 Amp.

The welding heads are the latest Standard General Electric Full Automatic Type, and one added feature is that the arc is controlled by means of a separate 6 volt, 750 amp. current from electro-plate generator set that energizes the backing-up bar immediately under the arc. This backing-up bar is 12" in length.

The pipe, which is 30' long, travels through under the arc and a flux is deposited on the joint to be welded to a depth of approximately 1½" and 2" wide, of a convex shape, and the welding wire feeding thru a stationary head cuts through the flux, entirely covering the arc from the atmosphere, and which likewise fluxes and anneals the deposited welded material.

42 Sample #13 is typical of this weld made on the above-described welding units in Los Angeles, and at times was practically free from all holes and in other regards, such as ductility and tensile strength was entirely acceptable for our purposes, and was produced using 36 to 38 volts, 570 to 600 amperes with bare 3/16 welding wire, and a welding speed of 12 per minute.

Sample #14 is with the same steel, wire, flux, voltage, amperage and speed as Sample 13, the only exception being that it was welded on a mandrule type welding machine in our San Francisco plant, a description of which I am enclosing herewith.

Samples 11 and 12 were welded in our Los Angeles plant, using om 11 – 48 v., 825 amps., and a welding speed of 20 per minute. Sample 12 was at 45 v., 750 amps., and a welding speed of 16½ per min. 3/16" wire and our flux was used on both of these samples.

Our experiments have nearly convinced us that the steel, wire, or flux does not alter to any considerable extent the conditions causing these holes, and we have encountered conditions involving electrical disturbances, particularly the method of grounding the machine, that affect the size and frequency of the holes and by insulation of the machines from all contact with water pipe, conduits, buildings, frame work of the welding unit, etc., we have been able to almost entirely eliminate them.

However, for your information, the wire being used is Grade EB! manufactured by the American Steel and Wire Company, and analyzes as follows:

Carbon	.13 to .13
Manganese	.40 to .00
Sulphur	.04 maximum
Phosphorous	.04
Silicon	.04

with the silicon usually running approximately .02.

The 1/4" plates in Samples 11 to #14 inclusive are from the Birmingham Mills of the U. S. Steel Corporation, rolled especially for welding and analyze as follows:

Carbon	.22
Manganese	.45
Phosphorous	.02
Sulphur	.01
Silicon	.02

We are using a flux, a sample of which is enclosed with samples of weld, which is composed of silica clay ground to approximately 200 mesh, lime and ferro-maganese being added to bring about the following analysis:

43	Silica (SiO_2)	48.20%
	Aluminum Oxide (Al_2O_3)	21.50
	Iron Oxide (FEl_2O_3)	2.10
	Titanium Oxide (TiO_2)	0.90
	Calcium Oxide (CaO)	10.00
	Magnesium Oxide (MgO)	0.83
	Sodium Oxide (Ne_2O)	1.10
	Potassium Oxide (K_2O)	0.96
	Moisture and combined water	8.94
	Carbon Dioxide (CO_2)	1.29
	Ferro-manganese	4.36
	Phosphoric Anhydride (P_2O_5)	None
	Phosphoric Anhydride (P_2O_5)	
	Sulphuric Anhydride (SO_3)	
	Chlorine (Cl)	
		100.18%

The plate, wire, flux and the voltage, amperage and welding speeds have been experimented with to a considerable extent, and have been proven quite satisfactory on the 1/4 and 5/16" plate on the welding units in our Los Angeles plant, except for an occasional hole which would show in the top of the weld, but we have recently encountered a most unsatisfactory condition in regard to these holes in our San Francisco plant, welding the 1/ " plate on the mandrule type welding machine, as manufactured by the General Electric Company, modified by the addition of the aforementioned separately applied magnetic current to control the arc and the additional use of flux.

The 1/2" plate in samples No. 1 to 10 inclusive analyze as follows:

Carbon	.13
Manganese	.60
Phosphorous	.075
Sulphur	.035
Silicon	.06 to .09

Plates of a more suitable analysis for welding purposes have not appreciably improved conditions. The 1/2" plate

is planed at 35 degrees, leaving a 1/16 shoulder at the bottom, and is of course perfectly formed and tacked before entering the welding machine.

Samples 1 to 10 inclusive were welded under the following conditions:

Sample #1—
30 v., 630 amps., 5" per min., 1/4" EB wire, using flux.

Sample #2—
30 v., 630 amps., 5" per min., 1/4" EB wire, without flux.

Sample #3—
20 v., 400 amps., 5" per min., 1/4" EB wire, without flux.

Sample #4—
20 v., 375 amps., 5" per min., 1/4" EB wire, without flux.

.44 Sample #5—
38 to 40 v., 850 amps., 11" per min., 1/4" EB wire; using flux.

Sample #6—
30 v., 600 amps., 5" per min., 3/16" EB wire, using flux.

Sample #7—
30 v., 600 amps., 5" per min., 3/16" EB wire, without flux.

Sample #8—
20 v., 375 amps., 5" per min., 3/16" EB wire without flux.

Sample #9—
38 to 40 v., 900 amps., 11" per min., 1/4" EB wire, using flux.

Sample #10—
38 v., 850 amps., 12" per min., 1/4" EB wire, using flux.

You may make such examinations and conduct such tests as you deem necessary to form an opinion as to the nature and causes of these holes, and trust that you can make the necessary arrangements with the Commanding Officer for conducting these tests, advising us regarding the cost, which we will of course immediately compensate the department for.

We appreciate the fact that this may not be a simple problem and may entail some rather lengthy and costly experiments and possibly some radical changes in our equipment, but if you think that through our combined efforts these holes can be eliminated we will naturally desire to engage your personal services in a manner satisfactory to

yourself, in order that we may diligently prosecute this work.

Thanking you for the interest you have already taken in this matter, and hoping that we may hear from you as soon as possible, we remain,

Yours very truly,
Western Pipe & Steel Co. of California,
Assistant Manager.

LWD:GT

45 PLAINTIFF'S EXHIBIT NO. 151.

The Linde Air Products Company *vs.* Graver Tank & Mfg. Co. Inc., et al.

Welding Conditions for Plaintiff's Demonstrations Given in Connection with the Testimony of Harry Kennedy.

Demonstration No. 1—Hand Welding—Bare Electrode.

3/16" Bare rod, GE, Type L
200 Amperes, Straight Polarity
600 Amperes, Straight Polarity

Demonstration No. 2—Hand Welding—Coated Electrode.

3/16" Coated rod, GE, Type W-24
225 Amperes, Straight Polarity

Demonstration No. 3—Automatic Welding, on 1/2" Plate.

Unionmelt 20
1/4" Oxweld No. 36 rod
1/2" Plate, with 60 degree included angle—3/16" nose
850 Amperes, 28 Volts; Reversed Polarity
16" Per Minute

46 Demonstration No. 4—Automatic Welding on 1" Plate.

First half of plate—Unionmelt 20
Second half of plate—Clay Flux, with following analysis:

SiO_2	53.94
Al_2O_3	19.26
Tot. Fe	2.36
TiO_2	1.40
CaO	5.14
MgO	0.75
Na_2O	2.30
Tot. Mn.	6.60
Tot. C	.69
CO_2	.18
H_2O 1000°	7.50

5/16" Oxweld No. 36 rod
1" Plate, with 35 degree included angle, 1/8" nose
Alternating current, 1550 Amperes, 41 Volts
11" per minute
Demonstration No. 5—Automatic Welding on 5/16" Plate.
Clay Flux, with same analysis as that used in Demonstration No. 4
3/16" Premier EB rod
5/16" Plate, with 70 degree included angle, feathered edge, no nose.
600 Amperes, 30 Volts, Straight Polarity
10" per minute.

47 PLAINTIFF'S EXHIBIT NO. 158.

The Linde Air Products Co.

New York Office,
December 29th, 1933.

Mr. J. B. Hirst,
San Francisco, Calif.

Via Special Delivery—Registered Mail.

Dear Mr. Hirst:—

I am enclosing the Application, Oath, Power of Attorney and Assignment covering the continuing application to be filed in the United States Patent Office covering the electric welding process. I am also enclosing Mr. Greenwald's letter to me giving the necessary instructions regarding the execution of the various enclosed documents.

It is our intention to file the enclosed application as a continuation in part of co-pending application Serial Number 657,836, filed February 21st, 1933, and continue the prosecution of both applications.

The enclosed application was prepared by Mr. Scheffler and I feel that he has done an excellent job in the preparation in view of the conditions. There was some question regarding the term that should be used to cover the material called a "flux" in the previous application. Kennedy suggested that it be called a "fused electrolyte" but this did not meet with the approval of Mr. Becket. We consid-

ered the possibilities of calling it a "conductive slag" or "fused resistor", but it seemed advisable to call it a "conductive melt" as the inventors are at liberty to define their own terms in a patent application.

It appeared inadvisable to try to cover the specific composition of a flux in this application owing to the fact that the field has not been entirely covered by research work and that due to the fact that there should be no prior art on this particular type of material, it was felt that all materials having the necessary characteristics to produce a good weld could be covered in the claims and the claims have been directed to this protection. There are, however, specific claims directed to the calcium silicates, calcium magnesium silicates and manganese silicates with the addition of calcium fluoride.

I have gone over all of the contained subject matter in the proposed application with Mr. Becket and he is entirely in accord with the manner in which the specification and claims have been drawn. It is quite possible that certain features of the specification may seem objectionable on the first reading, but these matters have all been carefully considered and the general feeling is that it should be filed in its present form. You will note that the welding process has been defined as a process entirely different from the arc welding process and consequently the use of the arc has been excluded throughout the application. This is also true in the case of the word "flux" which has been replaced by the term "conductive melt".

48

Mr. Scheffler feels that we will have no difficulty in obtaining a strong patent covering the welding process and the material used for the resistor. It appears that the other interested parties have about the same feeling in this connection.

I would appreciate it if you would have the enclosed documents executed as soon as possible and returned to me by regular registered mail, special delivery. Owing to the possibility of these documents being lost if sent by air mail, it seems advisable to return them by regular mail as the documents cannot be sent in duplicate. I assume that the enclosed will reach you not later than Tuesday, January 2nd and that they will be back in New York on January 8th, which will give us ample time for filing this application previous to the filing of the foreign applications.

It is quite possible that certain expenses will be incurred in the execution of the enclosed documents and other documents pertaining to the foreign patents in the way of notary fees and other expenses. Under the terms of the contract we are obligated to pay all these charges and I assume that you will be able to take care of them through the San Francisco Office. We have opened up an account in the name of The Linde Air Products Company which is called the "J. K. R. Process" account for expenditures made by The Linde Air Company in connection with the Jones-Kennedy-Rotermund electric welding process. Any charges that are incurred should be charged to this account.

Very truly yours,

R. E. Cornwell.

R. F. Cornwell.
KGK

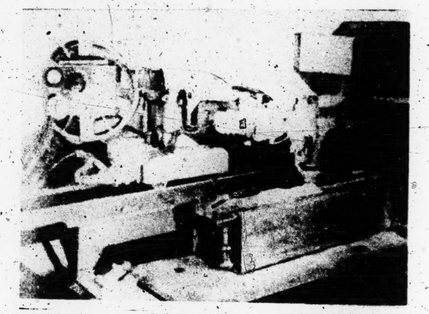
Encs.

P. S. Had intended to send papers for foreign applications to you for execution together with enclosed United States patent application, but will be unable to send them until the first of next week. Will send them to you by air mail either Tuesday or Wednesday.

R. E. C.

CHART SHOWING

WELDING ACTION WHICH TAKES PLACE IN PROCESS OF JONES ET AL PATENT 2043960



(PAGE 15)

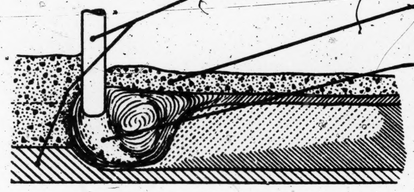
UNIONMELT APPARATUS CATALOG
1945 EDITION

CC

CHART SHOWING

ACTION WHICH TAKES PLACE IN PROCESS OF JONES ET AL PATENT 2043960

CONDUCTION OF ELECTRIC CURRENT



ROD & PLATE

Terminals of electric supply circuit are connected to them. Applies an electric voltage (pressure) tending to force current to pass from one to the other.

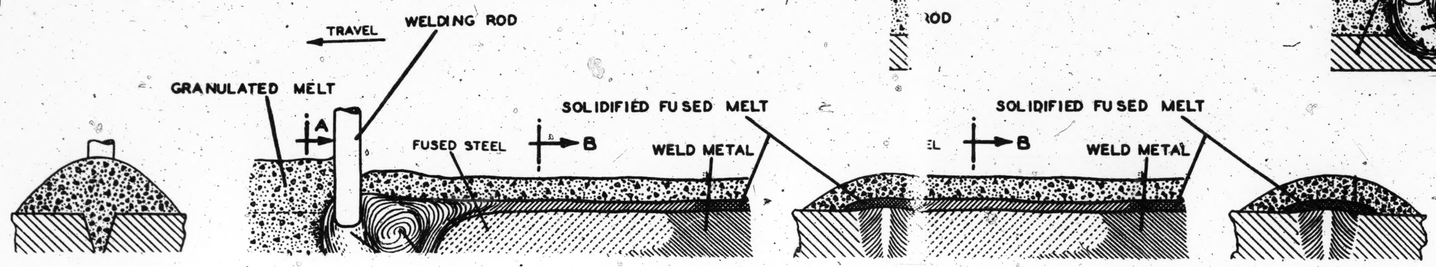
GRANULATED MELT

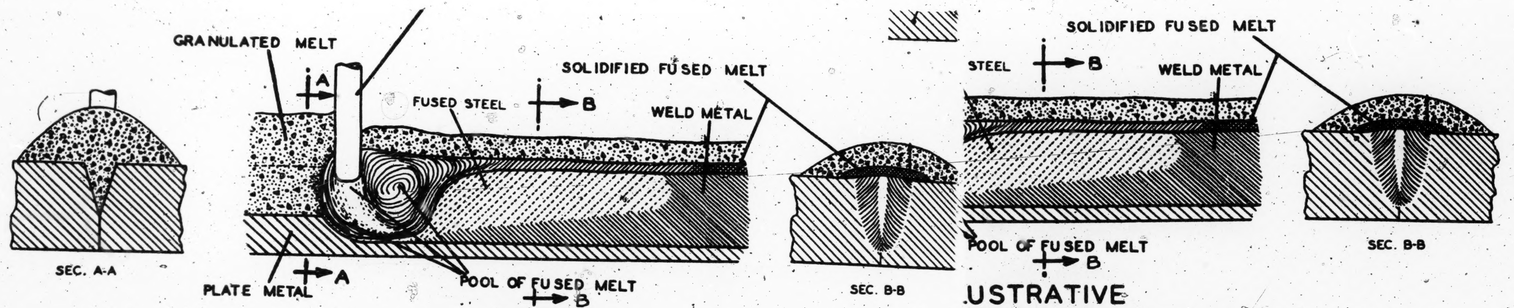
Non-conductor of electric current.

POOL OF MELT FUSED IN SITU

Path of Current: All electric current flowing between rod and plate passes through the pool of fused melt. Entire pool is ionized (i.e., molecules are broken up into ions and free electrons bearing the electric charges which make up the "current"). Core of pool is of low density, probably made up of a swirling mixture of melt vapor and mist mixed with iron vapor and mist. Largest proportion of electric charges (current) is borne by the more rapidly moving electrons in this core or inner portion of the pool. The boundary or outer portions of the pool are made up of liquid fused melt which is progressively more viscous (sticky) and less conductive in the regions of contact with the non-conductive granular melt.

Magnitude of Current: The electric current passed between rod and plate is of sufficient magnitude to maintain the conductivity of the pool of fused melt, fuse additional melt, and to fuse the rod and plate for coalescence of the same.





ILLUSTRATIVE

INTERIOR VIEW DURING WELDING

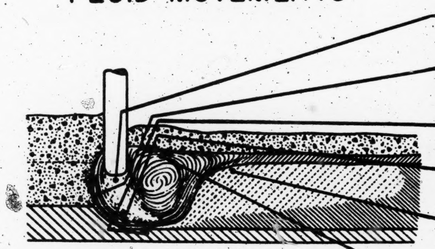
WITH PROCESS OF PATENT-IN-SUIT

NO 2043960

ILLUSTRATIVE

VIEW DURING WELDING

FLUID MOVEMENTS



Tip of rod fuses progressively, the resulting iron globules, vapor and mist mixing intimately with fused melt.

Granular melt is fused here by contact with approaching fused melt and sweeps downward across floor of crater.

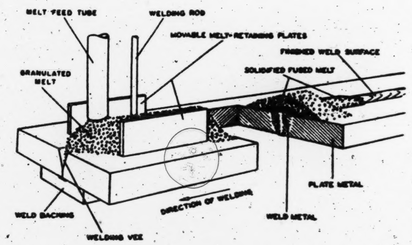
Plate metal in floor of crater is progressively fused.

Fused melt and plate metal intermingle and sweep rearward and upward.

Fused melt floats out of molten steel, freezing on top of weld and leaving underlying weld metal of high density and chemical purity. Any gas liberated in plate rises and escapes here.

Portion of fused melt rolls forward in a tide following and touching the rod to form a covering for the welding zone.

In general: the fused melt forms a circulating mantle for the welding zone from rod to plate, which is viscous (sticky) on its upper side, and through the walls of which mantle the metal enters at top (from rod) and at bottom (from plate), emerging in the trailing tail portion of the mantle where fused metal and melt separate, due to their difference in specific gravity, before solidifying.



(FIG. 1 PAGE 245)

WELDING HANDBOOK

51 PLAINTIFF'S EXHIBIT 190.

Conduction of Electric Current in an Ionized Gas or Liquid.

In order to understand what it is that takes place under the blanket of granular material in the Unionmelt welding process, it is necessary to know something about "ions" and "ionization" and the conduction of electric current in an ionized gas or liquid. This kind of conduction is strange to most persons without technical training, and it may be well to compare it with the more familiar concept of the conduction of electric current along a copper wire, with which we are all acquainted to a greater or lesser extent.

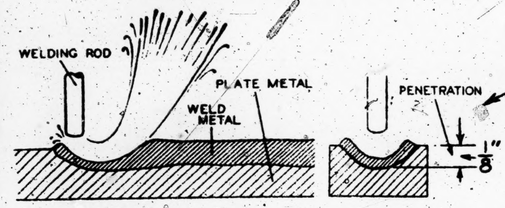
I.

We will have to start with the structure of an atom. Everybody is familiar with the fact that matter, even in its solid state, is not really a solid mass but that, on the contrary, each little particle or atom is somewhat like a very tiny solar system. There is a heavy nucleus, and around the nucleus the electrons revolve in something like orbits. The electrons are very small indeed, one of the protons (units making up the nucleus) is about 1800 times as big as an electron, so you can imagine that an electron hardly represents any mass or weight at all. This fact is
52 emphasized because only the electrons participate in the ordinary electric conduction along a copper wire, whereas the protons as well as the electrons are involved in ionic conduction.

Each proton carries a positive charge of electricity. Each electron carries a negative charge. In any atom in its normal state there are the same number of protons as electrons and the positive charges are equal to the negative charges, and there is an electrical balance. One fact about electricity we all know is that like charges repel each other and unlike charges attract each other. (At least, if we have played with magnets, we know that the north pole of one magnet will attract the south pole of another magnet, and there is this similarity between electrostatic and electromagnetic forces.) This attractive force, between the positive charges on the protons in the nucleus and the negative charges on the electrons, holds the electrons in their orbits around the nucleus.

PLAINTIFF'S EXHIBIT NO. 173.

ILLUSTRATIVE FIGURES FOR PRIOR ART WELDING PROCESSES

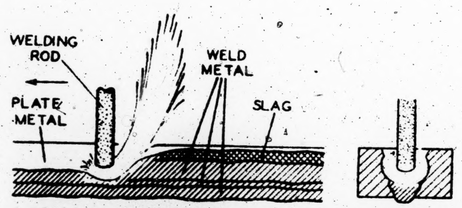


BARE ELECTRODE ARC WELDING

(FROM PG 131 WELDING HANDBOOK 1942)

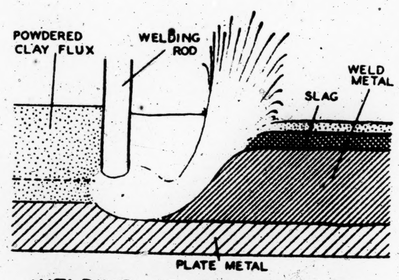
BARE ELECTRODE ARC WELDING

(FROM PG 131 WELDING HANDBOOK 1942)



COATED ELECTRODE ARC WELDING

(FROM PG.131 WELDING HANDBOOK 1942)



WELDING AS PRACTICED BY WESTERN PIPE & STEEL CO.

(SOMETIMES DESIGNATED "SMOTHERED ARC" OR "SUBMERGED ARC" WELDING.)

CHART SHOWING CONTRAST BETWEEN "ARCS OF THE USUAL TYPE" AND THE CONDUCTIVE PATH IN JONES ET AL PATENT NO 2043960

CHART SHOWING AST BETWEEN "ARCS OF USUAL TYPE" AND THE IVE PATH IN JONES ET AL ENT NO 2043960

	PRIOR ART OPEN ARC WELDING PROCESSES	PROCESS OF JON PATENT-IN-SU NO. 204396	PROCESS OF JONES ET AL PATENT-IN-SUIT NO. 2043960
	Free gaseous atmosphere between rod and plate: A free atmosphere of gas extends between rod and plate. In this gaseous atmosphere the molecules of air and of steel are ionized, thereby being rendered capable of carrying the electric charges which constitute the "current". Such an electric discharge in a gaseous atmosphere is commonly designated as an "arc". Much of the air present (oxygen 20, nitrogen 80) reacts with the superheated finely divided steel and injures its properties.	Pool of fused melt between rod an ly absent in this process is any ; e: A mosphere. Such atmosphere is exc nd by a pool of fused melt which con ules and plate. The entire pool is ion ng rendered electrically conductive. arges pool is of low density, being con tric melt and rod. If density in this y enough to be classed as being in sent then conduction through this vapo rheated mated as an "arc" since vapor is, ies. ing, a gas. The arc which appear within the pool of fused melt is, by vaporous melt itself (with a p of iron vapor) within the mantle melt and which mantle also partic conduction. In the sense and ter Jones et al patent, any "arc of t or "air-conducted" or "gas-conduc cluded from the welding zone by i rod in the pool of fused melt.	Pool of fused melt between rod and plate: Typically absent in this process is any free gaseous atmosphere. Such atmosphere is excluded (displaced) by a pool of fused melt which contacts both the rod and plate. The entire pool is ionized and thereby rendered electrically conductive. The core of the pool is of low density, being constituted by fused melt and rod. If density in this core is low enough to be classed as being in the vapor phase, then conduction through this vapor may be designated as an "arc" since vapor is, strictly speaking, a gas. The arc which appears to be present within the pool of fused melt is, however, formed by vaporous melt itself (with a probable admixture of iron vapor) within the mantle of liquid fused melt and which mantle also participates in the conduction. In the sense and terminology of the Jones et al patent, any "arc of the usual type", or "air-conducted" or "gas-conducted" arc is excluded from the welding zone by immersion of the rod in the pool of fused melt.
	Generation of additional gas for the welding zone: In all of these prior practices a large volume of gas is generated at the welding zone as the rod melts. Gases are generated which help stabilize the arc. In coated rods this was a more or less fortuitous result, intent of putting gas generating materials in the coating having been to shield the weld from the air by a blanket of gas. Shielding by such blanket is, however, quite incomplete.	Prevention of gas generation at the weld In the Jones et al process, generation o the welding zone is rigorously suppresse " e e e the composition should be substa anhydrous and free from gases, and all re which would evolve deleterious amounts o during welding should be substantially c before the medium is used in the welding (p. 3, col. 1, lines 5-11).	ing zone: olume of e rod obilize or less generat- to shield . Shield- complete. Prevention of gas generation at the welding zone: In the Jones et al process, generation of gas at the welding zone is rigorously suppressed. " e e e the composition should be substantially anhydrous and free from gases, and all reactions which would evolve deleterious amounts of gases during welding should be substantially completed before the medium is used in the welding process". (p. 3, col. 1, lines 5-11).
	Blinding Glare: Brilliant and dazzling light is emitted by the open arc, requiring operator to use a heavily opaque shield. The heat radiated to operator is nearly unbearable and showers of molten metal from the partially enclosed arc render it impractical with high currents.	Absence of Blinding Glare: When normal b granular melt is used there is "no visibl ing and, indeed, scarcely any external ev that a weld is being made". (Jones et al p. 3, col. 2, lines 15-17).	ight is or to distad ers of arc Absence of Blinding Glare: When normal burden of granular melt is used there is "no visible sparking and, indeed, scarcely any external evidence that a weld is being made". (Jones et al patent, p. 3, col. 2, lines 15-17).
	Maximum usable current is rigidly limited: In each of the forms of metal arc welding available in the prior art there was a rigid, inherent limitation on the maximum current that could be employed. Currents in excess of such values sent the metal in a wild and useless spatter. For high quality welds a coated electrode was imperative and its current, with for example a $\frac{1}{4}$" diameter electrode, was limited to about 300 amperes. Limitation on current gave a limited depth of penetration for each pass. About 1/8" was maximum depth of penetration, per pass, with a coated electrode. For clay flux maximum penetration was approximately $\frac{1}{4}$".	Usable current has been multiplied many t the Jones et al process current can be in to 1200 amperes when using a $\frac{1}{4}$" diameter Penetration is greatly increased, making one-half inch plate in a single pass. Pe etration melts larger proportion of plate economizes rod. Ratio of plate to rod mel increased from about 10 to 25% for prior p to about 66-2/3% for the Jones et al proc	In each in the ation on . Cur- al in a welds a rent, s limit- rent h pass. per ux maxi- Usable current has been multiplied many times: In the Jones et al process current can be increased to 1200 amperes when using a $\frac{1}{4}$" diameter electrode. Penetration is greatly increased, making it possible to weld one inch, two inch or even two and one-half inch plate in a single pass. Greater penetration melts larger proportion of plate metal and economizes rod. Ratio of plate to rod melted is increased from about 10 to 25% for prior processes to about 66-2/3% for the Jones et al process.

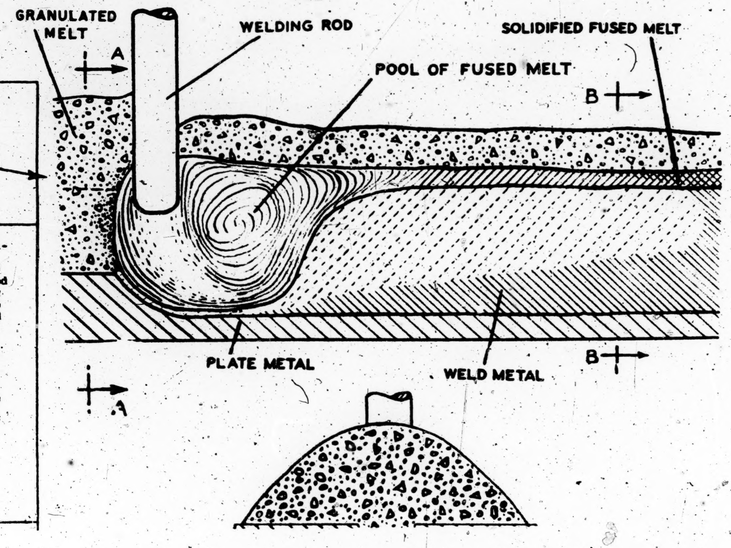
SCALE OF ALL DRAWINGS

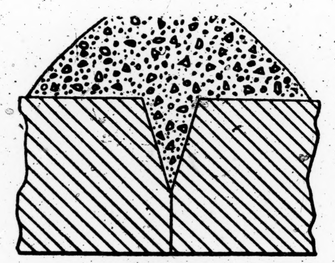
APPROX. 2" = 1"

SCALE OF ALL DRAWINGS

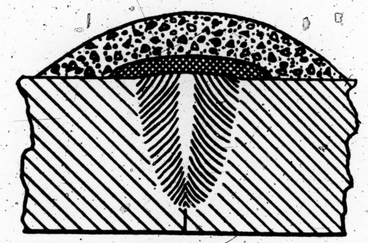
APPROX. 2" = 1"

JONES ET AL PATENT NO 2043960





SEC. A-A



SEC. B-B

II.

Copper is an element which is composed of atoms containing many electrons and it is easy for an electron from one atom to shift over and replace an electron in a neighboring atom. That makes copper a good conductor of electricity.

53 An electric generator is a machine for transferring electrons or electric charges from its positive side and piling them upon its negative side. Thus the negative terminal of an electric generator will be crowded with electrons or negative electric charges, and contrariwise there will be a scarcity of electrons on its positive terminal. The electrons on the negative terminal are looking for a path to escape.

If we connect one end of a copper wire to the negative terminal and the other end to the positive terminal of the generator, the copper wire furnishes a path for the electrons. The electrons rush off of the negative terminal along the wire and the deficiency of electrons on the positive terminal acts somewhat like a sponge and soaks up the electrons.

The flow of current through the wire is instantaneous or practically so. This does not mean that identically the same electrons instantly pass through the entire length of the wire. It is more like knocking down a row of toy soldiers or dominoes set up on end. The electrons from the negative terminal rush into that end of the wire and displace some of the electrons there (like charges repel each other, and negative electrons repel other negative electrons) and push them further along, and these in turn push other electrons along the wire, and so on down to the
54 other end of the wire where the positive terminal is attracting or sucking up electrons. An individual electron does not move very far—it just moves over and the repelling force sends a neighboring electron along.

The protons making up the great mass of the wire do not participate in this flow of current, and we cannot see any movement of the wire at all.

61 PLAINTIFF'S EXHIBIT 227

National Tube Company
Christy Park Works
McKeesport, Pa.
P. O. Box 421

February 25th, 1929.

Mr. Geo. A. Reuff, General Superintendent,

Office.

Dear Sir:

In reference to Mr. A. M. Saunders' letter pertaining to obtaining patents covering our method of electric welding, we wish to state the following:

At the time we submitted the papers, we were aware of the fact that the ingredients of protective coating were broadly covered by other patentees and stated so in our letter to you.

The patents which Mr. Saunders enclosed with his letter are known to us and we have copies of them on our files. However, bear in mind that all of them speak of "metallic electrodes being covered with the above substances." We do not use this method at all. The method of covering electrodes has the following disadvantages:

The rod cannot be used from the reel in a continuous performance, because no fragile coating will stand winding on a drum. That means the coated wires must be used in short pieces and exchanged each time when the rod burns out. On automatic welding machines, this means loss of time, new point of start with each rod, in short, that means "discontinuity" of the process. We abandoned this method altogether and this should be taken out of the many varieties of our claims. First of all, we use a rod from a drum with so many thousand feet wound on it. The wire is automatically and continually consumed until the weld is completed, whichever the length of the weld may be.

We would like to concentrate all our efforts in getting a patent covering the features of electric welding whereby the bare electrode is inserted into the bed of a flux, covering completely the groove created between the two edges of plate. This is decidedly new and is of enormous ad-

III.

From what has already been said it will be seen that the familiar phrase "flow of electric current" may lead to an erroneous conclusion. The "electric current" is not some fluid which is shot into the wire like a jet of water shot into a pipe. Only the particles making up the wire itself are there; and it is the movement of the charged electron particles of the wire that we speak of as "current".

IV.

The mechanism of electric conduction in an ionized gas or liquid is basically different from that in the wire we have been considering. It is different in that the "current" is made up not only of electrons but also results from the
55 movement of positive and negative "ions". The two types of conduction are alike, however, in that both the "current" is constituted by charged particles of the medium in which conduction takes place.

As to "ions": Atoms and molecules (combinations of atoms to form chemical compounds) are not always in a nicely balanced electrical state. Things can happen to molecules which break them down into fragments which are not balanced electrically. Some fragments will have more electrons than protons and will, therefore, have a negative electric charge and these are called negative ions. Other fragments will have more protons than electrons and these are called positive ions.

Another peculiarity of ion conduction is that it takes place in a substance which when cold is an electric insulator and which becomes conductive only when heated sufficiently. In contrast, an electron conductor such as copper will be conductive whether cold or hot.

Various materials become ion conductors in different stages. Air is a familiar example of a gas that can be ionized and in that way rendered conductive even though it is an insulator at room temperatures.

56 The welding composition of the patent in suit belongs to a peculiar class of materials which, although non-conductive at room temperature in their solid state, are ionized in their fused condition, being ion type conductors in both their liquid and vapor states.

When a pair of leads or wires from a generator are

vantage in welding pipe where the continuity of the process means time and labor saving.

Our process resembles very much the methods used in producing steel in electric furnaces. Two electrodes are inserted in the furnace, one positive and one negative; the current flows from one electrode to the other and melts the charged metal covered with flux. In our case, the metallic (instead of carbon as in electric furnace) electrode which is one pole, set in continuous motion at a predetermined speed, is a negative pole; the plate is a positive pole. Instead of having a charge of metal as it is in the case in electric furnace and which could be done in our case, the metallic electrode burns off depositing the charge in the groove covered with flux. We believe that our method of welding should be called "Portable electric furnace welding method."

The ingredients of the flux are such that when a temperature of 5000° which is about the temperature of the arc, comes in contact with it, it transfers it into slag with a specific gravity lighter than the metal deposited. The metal through its gravity finds the lower levels of the groove, the slag floats on top. The metal deposited remains longer in a liquid state, due to slag protection and permits the gaseous cinelusions to reach the top of the surface 61½ before the metal is solidified. The slag protects the metal from coming in contact with air and all its damaging effects upon the quality of the deposited metal.

Avoiding the discussion of what takes place during the process, the actual facts observed in our welds are as follows: extreme ductility; freedom from pin holes; cup fracture appearance of the weld when pulled; silky, fine grain of fractures, very often impossible to distinguish from the breaks on parent metal. No "coated" wire, to our knowledge, ever produced a weld comparable to ours.

While experimenting for the last two years on the method as described above, we believe our claims could be extended in some other directions as originally mentioned. In performing the coating of electrodes the practice of others is as follows: A rod of certain lengths, 12", 18" or 24" is either submerged in a container a number of times, or a putty like coating is applied by hand or mechanically. We claim an automatic and continuous method of coating the wire. While the bare wire unwinds from the drum, through the welding machine, and descends towards the

applied to such an ionized pool of the welding composition of the patent, the positive ions move toward the negative wire and the negative ions and electrons move toward the other positive wire. There is thus a flow of electric current through the pool.

V.

The amount of current that flows through such an ionized pool depends upon how free the ions and electrons are to move. In general, that freedom of movement becomes greater as the liquid becomes hotter and more fluid (less viscous or sticky). The freedom of movement of the ions and electrons becomes even greater if the material is heated enough to vaporize, there being fewer collisions of the particles.

In the welding process of the Jones et al. patent the
57 welding rod is negative and the plate positive (or vice versa) with the pool of fused composition between them. All of the pool is "ionized". Current thus flows throughout the pool between the rod and plate. The concentration of heat is greatest at the center or core of the pool, and the composition there is vaporized. The ions and electrons there having greater freedom of movement, a larger proportion of the current is made up of their charges. But throughout the pool, both in its vaporous core and surrounding liquid mantle, the mechanism of current conduction is basically the same, viz.: a progression of positive ions in one direction and of negative ions and electrons in the other.

groove and comes in contact with the flux deposited in the groove, the flux being finely ground and having 30% of iron oxide, is magnetic in its character. As soon as the metallic electrodes come in contact with the flux and is automatically and continuously covered with heavy flux. As the metallic rod is automatically forced down in proportion to the rate of its consumption, each new portion of the metallic rod nearest to the flux attracts the flux. The advantage of this method as compared with coating on each individual piece is evident. This point is so striking and to our knowledge so novel, that, we will suggest serious consideration.

In reference to patents issued to Gravens, No. 1260875 and 1260989, we do not believe we infringe upon them.

I hope I have answered all questions included in Mr. Saunder's letter.

Very truly yours,
B. Robinoff,
Assistant General Superintendent.

BR:H

P. S. Omit the word "deoxidizing" from the first description sent you. Sketches 2 and 3 on our first drawing did not prove to be successful. If possible to protect claims, do so.

58 PLAINTIFF'S EXHIBIT NO. 191.

The Linde Air Products Company *vs.* Graver Tank & Mfg. Co. Inc., et al.

Welding Conditions for Plaintiff's Demonstrations Given in Connection with the Testimony of Dr. Gilbert E. Doan.
Demonstration No. 6—Automatic Welding on 3/4" Plate
Lincolnweld 660.
Lincolnweld Welding Head List No. 17208-10.
7/32" Lincoln Electrode.
3/4" Plate.
1st Side.
60° Included angle—1/8" deep.
700 Amperes, 34 Volts, Reversed Polarity.
12" per minute.
2nd Side.
70° Included angle, 3/8" deep.
925 Amperes, 35 Volts, Reversed Polarity.
12" per minute.
Demonstration No. 7—Automatic Welding on 1/2" Plate.
First third of plate—Unionmelt 20.
Second third of plate—Lincolnweld 660.
Third third of plate—Clay Flux, with same analysis as that used in Demonstration No. 4.
1/4" Oxweld No. 36 rod.
1/2" Plate, with 60 degree included angle—3/16" root.
850 Amperes, 28 Volts, Reversed Polarity.
16" per minute.
1-1/4" Flux burden in each case.
Plates ground on top and bottom.

PLAINTIFF'S EXHIBIT NO. 193.

EXPLANATORY CHART FOR THE CHEMISTRY OF WELDING COMPOSITIONS OF JONES ET AL PATENT NO. 2,043,960

METALS

CALCIUM (Ca) — MAGNESIUM (Mg) — MANGANESE (Mn) — ALUMINUM (Al)

GAS

OXYGEN (O)

METAL

SILICON (Si)

GAS

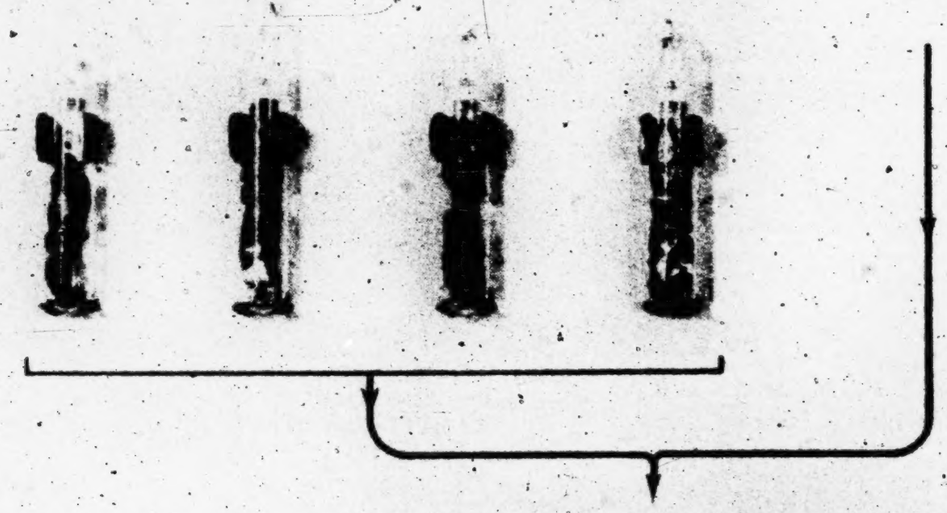
OXYGEN (O)

METAL

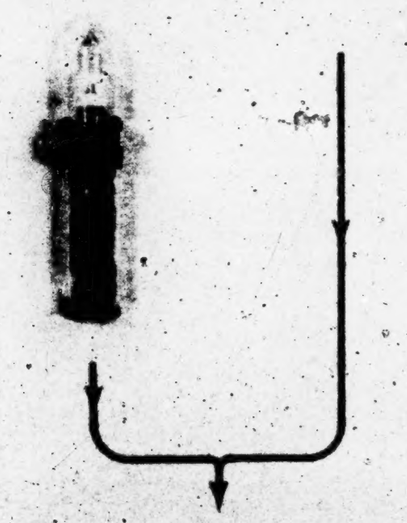
CALCIUM (Ca)

GAS

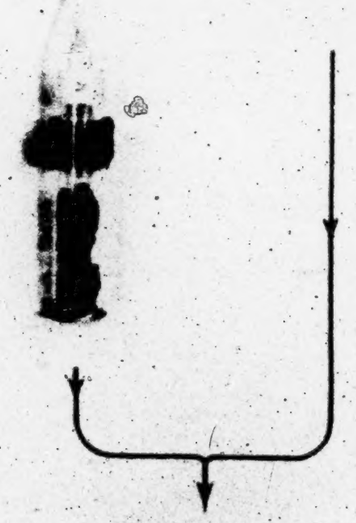
FLUORINE (F)



BASIC METALLIC OXIDES



ACIDIC METALLIC OXIDE



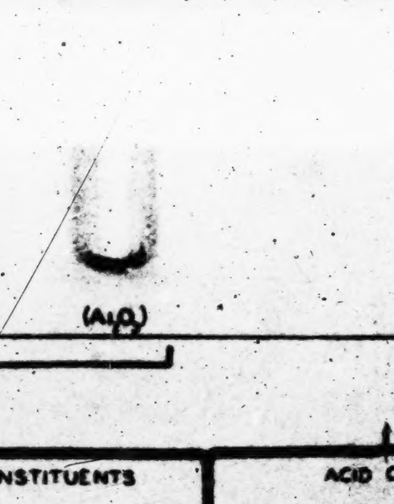
HALIDE SALT

CALCIUM OXIDE (LIME)	MAGNESIUM OXIDE (MAGNESIA)	MANGANESE OXIDE (MANGANOUS OXIDE)	ALUMINUM OXIDE (ALUMINA)	SILICON DIOXIDE (SILICA)	CALCIUM FLUORIDE (FLUORSPAR)
CaO	MgO	MnO	Al_2O_3	SiO_2	CaF_2

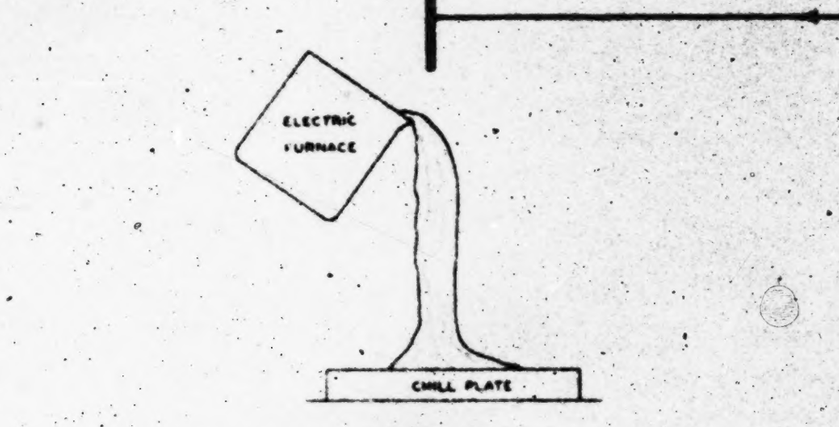
BASIC CONSTITUENTS — ACID CONSTITUENT

FUSION OF ACID AND BASIC CONSTITUENTS YIELDS A METALLIC SILICATE (OR SALT) → ELECTRIC FURNACE

MINOR PROPORTION OF CaF_2 ADDED TO FUSED SILICATE (SALT)



CHILLED VITREOUS MATERIAL GROUND TO COMPLETE WELDING COMPOSITION



UNIONMELT GRADE 20.	UNIONMELT GRADE 90	LINCOLNWELD 880 FLUX

PLAINTIFF'S EXHIBIT NO. 194.

CHART SHOWING

CHEMICAL CONSTITUENTS

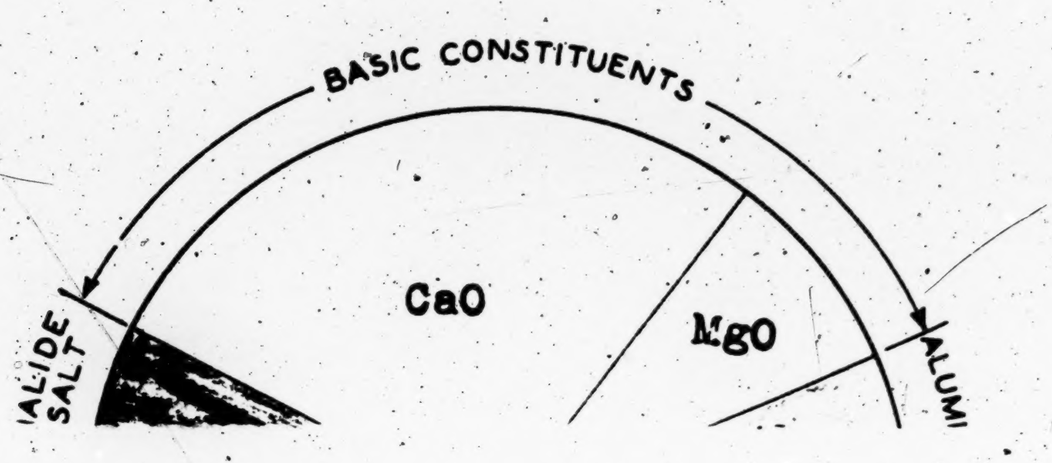
OF

JONES & "LINCOLNWELD" WELDING COMPOSITIONS

JONES ET AL 2.043.960

PATENT-IN-SUIT

1935-1936



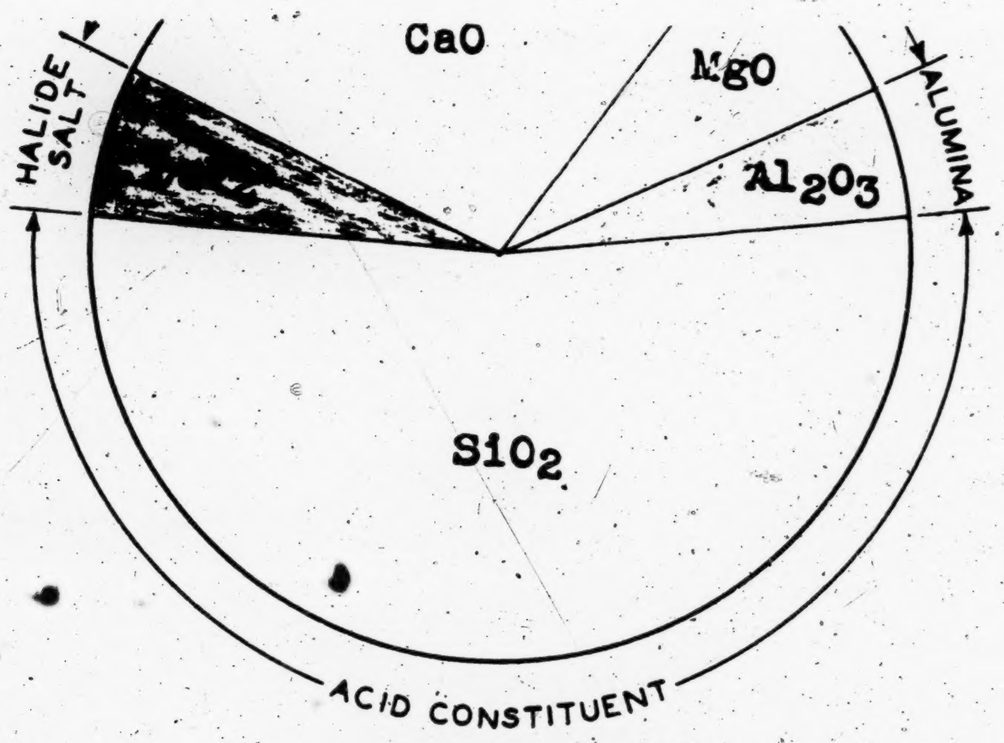


DIAGRAM SHOWING

CONSTITUENTS OF JONES WELDING COMPOSITION NO. 1

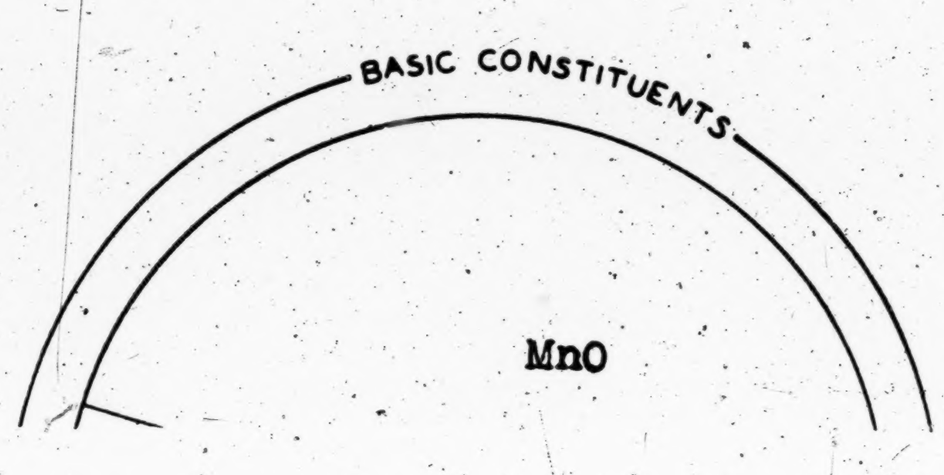
JONES ET-AL PATENT 2,043,960

(UNIONMELT NO. 20)

"LINCOLNWELD" WELDING COMPOSITION

USED BY

DEFENDANTS



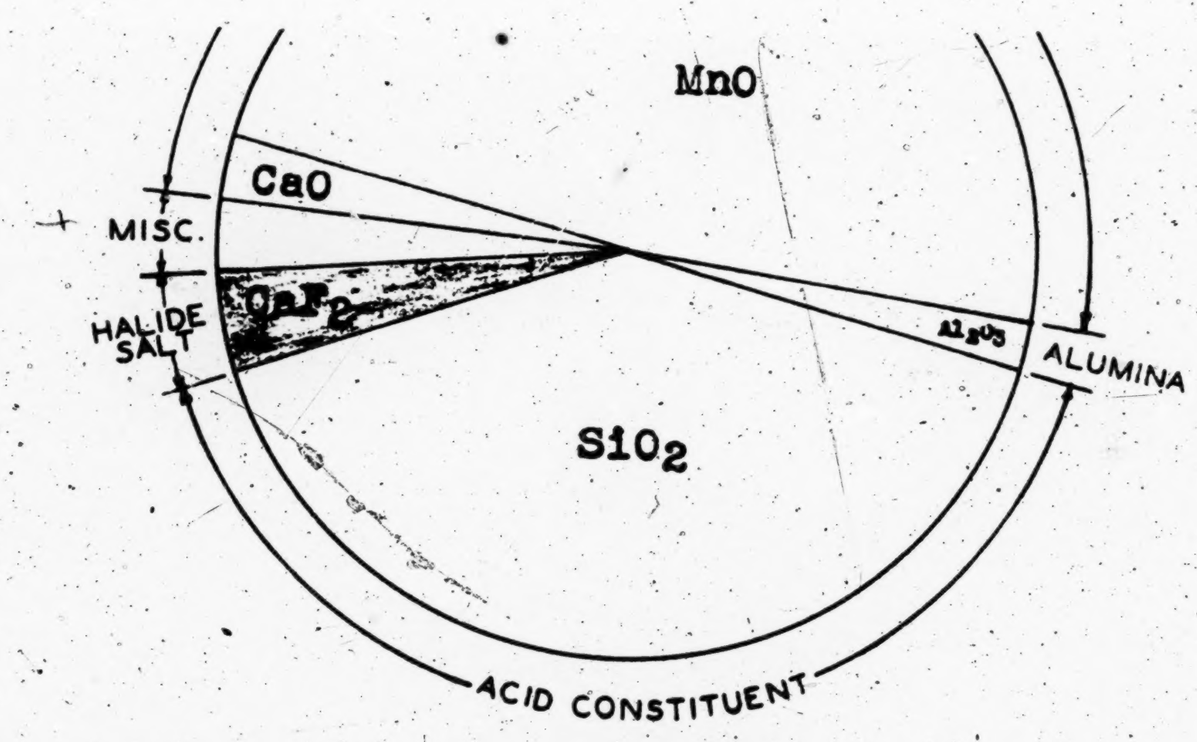


DIAGRAM SHOWING

CONSTITUENTS OF "LINCOLNWELD" WELDING COMPOSITION

(NO. 660)

Welding compositions which have been used successfully and which serve as representative examples within the invention have the following analyses, by weight:

	I	II	III	IV
Percent CaO	29.5	31.24	28.18	40.12
Percent MgO	8.7	11.01	8.26	0.89
Percent SiO_2	56.4	52.40	57.48	52.94
Percent Al_2O_3	5.4	4.11	4.86	5.80
Percent Fe_2O_3	Low	0.13	0.24	0.23

SILICATES, shown by → Percent CaO, Percent MgO, Percent SiO_2

ALUMINA, shown by → Percent Al_2O_3

CALCIUM FLUORIDE, specified → Before use about 1 part of calcium fluoride was added to 16 parts, by weight, of each of the above compositions.

(Spec., pp.2, col.2, line 64 to pp.3, col.1, line 3.)

Analysis

LINCOLNWELD "660" ELECTRIC WELDING COMPOSITION

(Flux 4)

SILICATES, shown by → Percent CaO ..... 2.66; Percent MnO ..... 48.19; Percent SiO_2 ..... 40.30

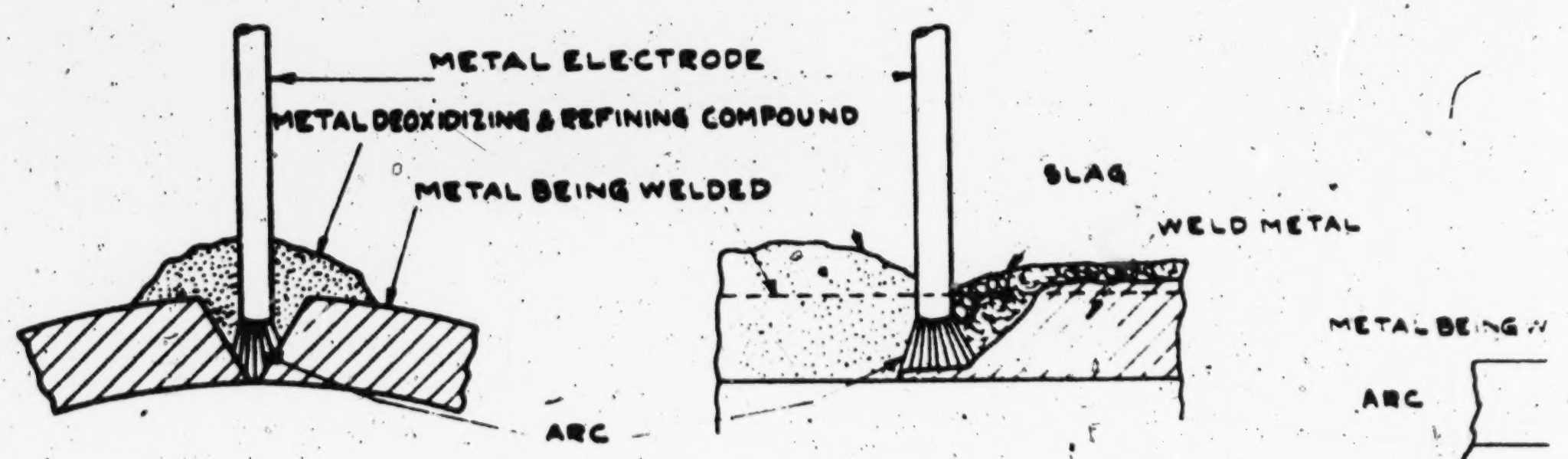
ALUMINA, shown by → Percent Al_2O_3 ..... 1.88; Percent Fe_2O_3 ..... 1.33

CALCIUM FLUORIDE (a Halide Salt) shown by → Percent CaF_2 ..... 3.92

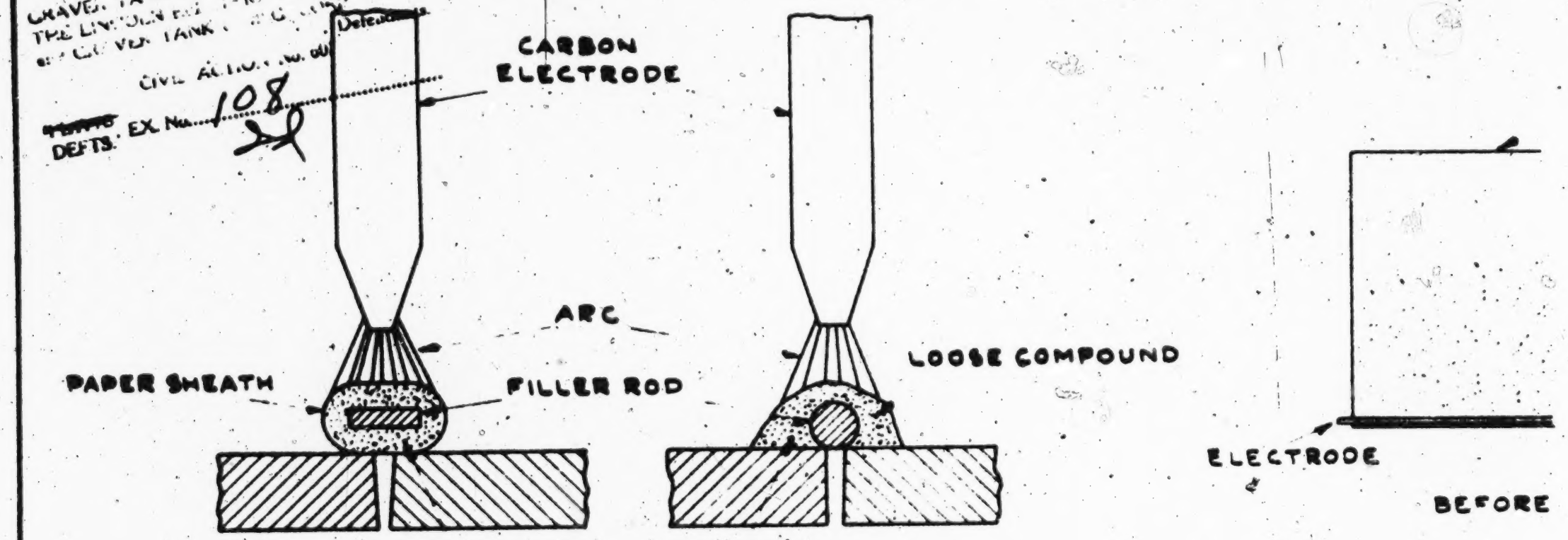
MISCELLANEOUS

Titanium Oxide →	TiO_2	0.10
Magnesium Oxide →	MgO	0.60
Barium Oxide →	BaO	0.87
Sulphur →	S	0.02

DEFENDANTS' EXHIBIT N

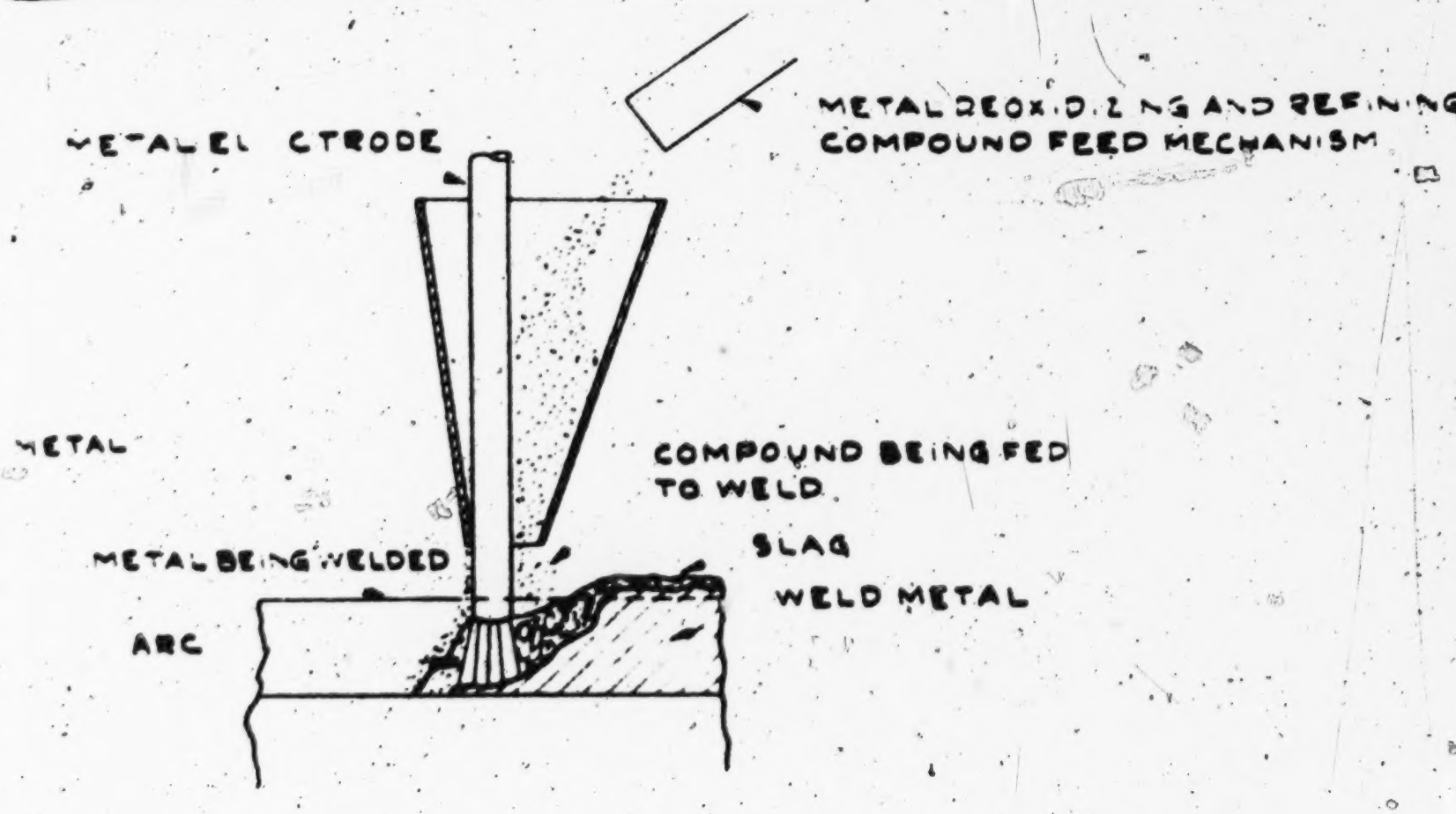


SKETCH N8.1



SKETCH N8.3

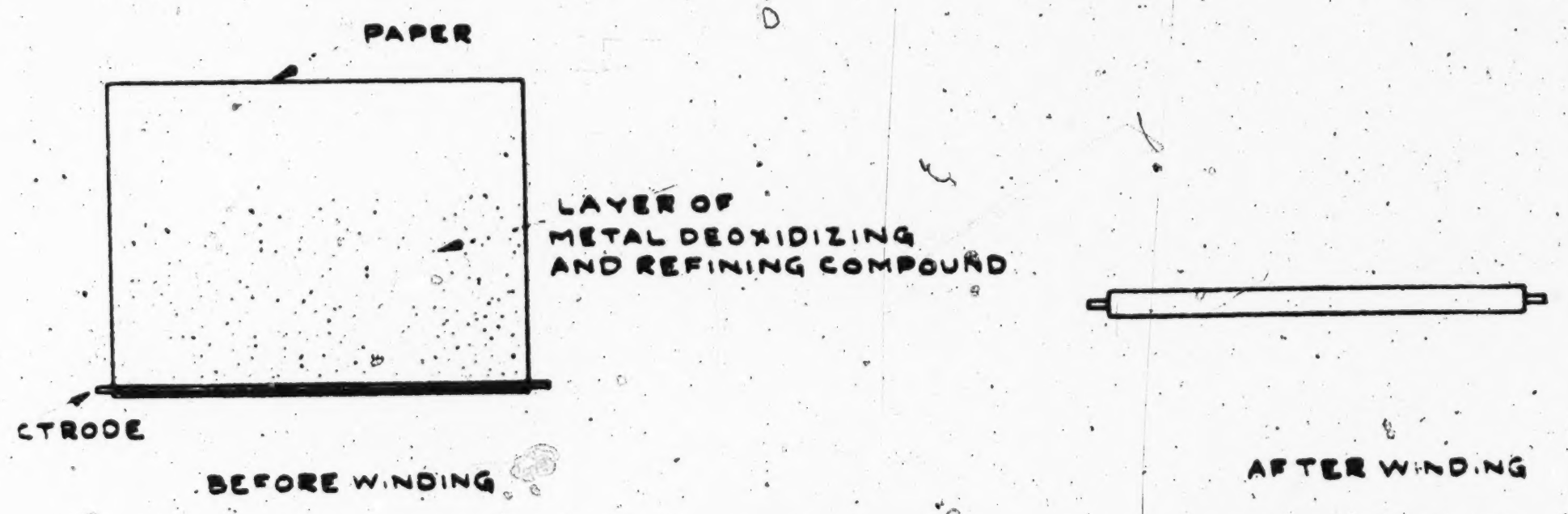
EXHIBIT NO. 108.



SKETCH N8.2

NATIONAL TUBE CO.
CHRISTY PARK WKS - HAMMERWELD DEPT.
SKETCHES REFERRING TO
DESCRIPTION OF IMPROVED
METHODS OF ELECTRIC ARC WELDING
OCT. 5, 1927

HW 1121



SKETCH N8.4

COPY

NATIONAL TUBE COMPANY
CHRISTY PARK WORKS
McKEESPORT, PA.
P. O. BOX 421

Mr. Works A. Reuff, Manager 5 February 24, 1926

TESTS (Cont'd.)

The remainder of the pipe was expanded on our sizing machine similar to the operation whenever we make an expansion joint. The pipe was expanded from both ends from 21-1/4" to 24-1/4" I.D., increasing the diameter 3" or 9.42" in circumference. Photographs below show the appearance of expanded pipe and a close view of the weld:

DEFENDANTS' EXHIBIT NO. 117-A.

DEFENDANTS' EXHIBIT NO. 117-B.

DEFENDANTS' EXHIBIT NO. 119.

The Linde Air Products Company v.
Graver Tank & Mfg. Co. Inc., et al.

Conditions for Defendants' Demonstrations
January 15, 1947

1. Demonstration of hand welding with coated rod

   1/4" Lincoln Fleetweld 11.

   5/8" plate, scarfed edges.

   Final pass in multiple pass handweld.

   350 amperes and 28 volts. Electrode negative.

2. Demonstration of hand welding with coated rod under Lincolnweld 660 Flux.

   3/16" Lincoln LH 70

   5/8" plate

   Bead laid on surface

   500-600 amperes and 30-40 volts. Electrode positive.

3. Demonstration of automatic welding under Lincolnweld 660 Flux (varying depth).

   7/32" Lincoln electrode.

   5/8" plate. square butt.

   First pass 800 amperes, 39 volts.

   Second pass 950 amperes, 41 volts.

4. Demonstration of submergence of arc under silica sand.

   7/32" Lincoln electrode.

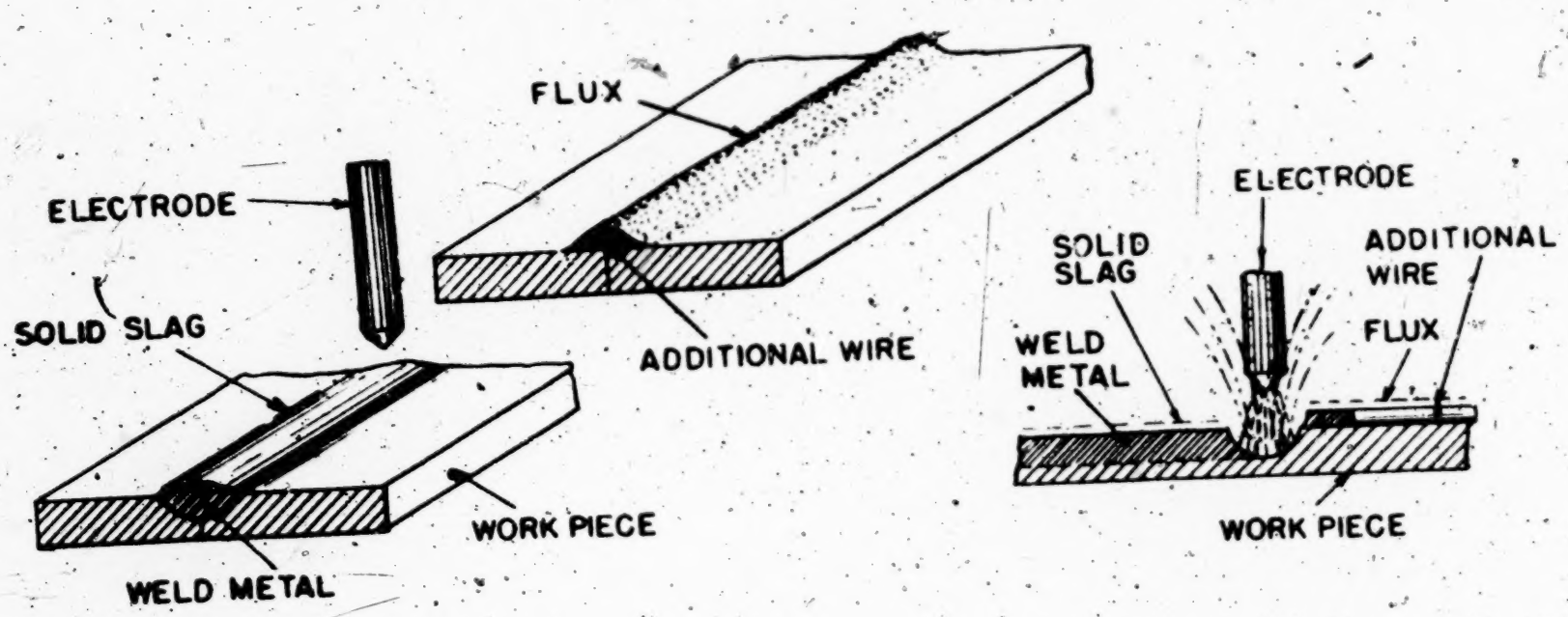
   5/8" plate. square butt.

   600 amperes, 35 volts (approximately).

DEFENDANTS' EXHIBIT NO. 139.

J.C.LINCOLN PATENT No.1,589,017

APPLN. FILED OCT. 11, 1918; PAT. ISSUED JUNE 15, 1926.



(Patent Specification)

". . . I have ascertained that in order to obtain ductility in a weld, it is necessary to avoid as far as possible, the oxidizing action of the air, and this I have accomplished by using both an inert gas about the arc, and a protective medium for the weld, which I may term a slag.

. . . . . .

"In connection with said inert gas, moreover, I may employ a slag covering for the welded seam, or this may be used independently for the purpose of excluding the air from the welded seam during its production. The material forming such slag is melted by the excessive heat of the arc, floats on top of the molten metal and serves as a protection therefor, which in conjunction with the inert gas, serves as an additional protection against oxidation and the result is a weld of such improved quality as to be sufficiently ductile for all practical purposes.

. . . . . .

. . the welding operation may initially embrace either a portion of, or the entire thickness of the sheets to be welded; although the latter contemplates complete welding at a single operation, and consequently may be accomplished more rapidly than when the intersecting welds must be formed from opposite faces of the metal.

"The sheets a b are positioned with their edges substantially in abutment, as shown in Figs. 2 to 6. A strip c or wire d of steel or alloy, such as nickel-steel or chromium-steel, for example is placed adjacent to the abutting edges, and the flux e is supplied to cover the parts, as in Fig. 4. I may use asbestos, sodium-carbonate, borax or other suitable materials for the flux; the requisite thereof being that it will persist beneath the electric arc in sufficient volume to cover and exclude the air from the molten metal.

. . . . . .

"It should be understood that the arc-welding described is fabricated beneath a suitable inert medium, either solid or gaseous or both in conjunction. Thus in Fig. 4, the flux e is shown in position for arc-welding, while in Fig. 5, the partial seam weld a' has been formed by the electrode h and a crust e' still remains from the excess of fluxing inert material employed.

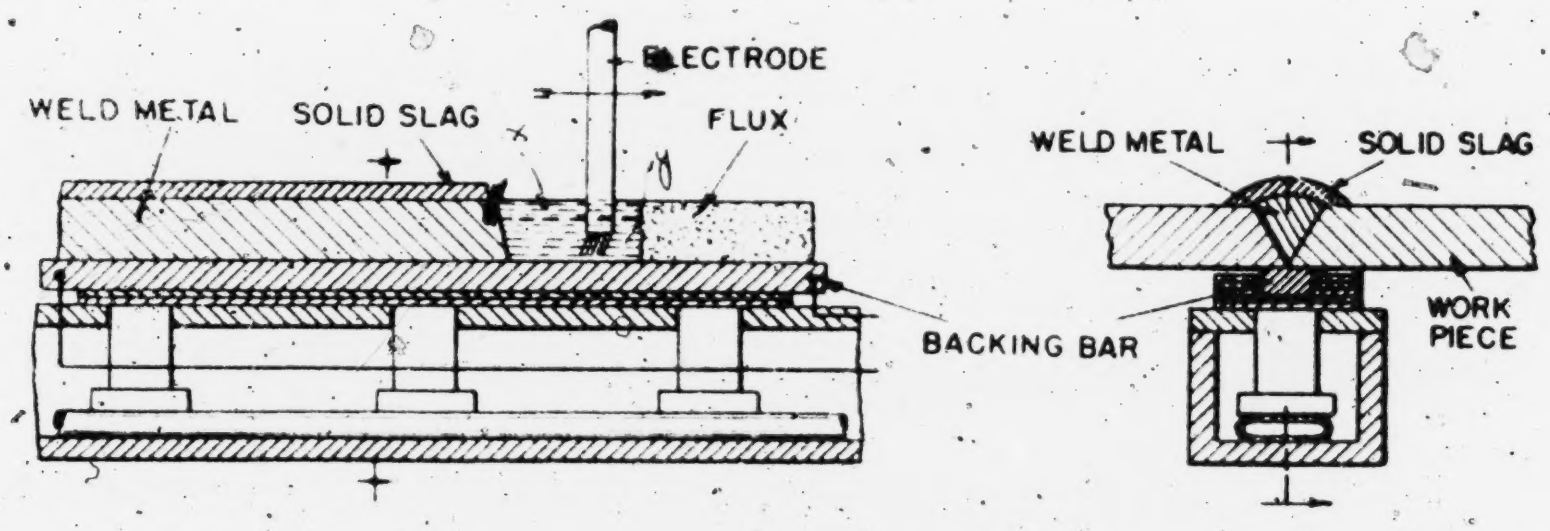
. . . . . .

"These welding operations take place under ideal conditions for producing a ductile weld, by maintaining the molten metal within or beneath a protecting inert covering, either gaseous or solid, or both combined."

DEFENDANTS' EXHIBIT NO. 140.

ROBINOFF PROCESS - PATENT No 1,782,316

APPLN. FILED MAY 10, 1929; PAT. ISSUED NOV. 18, 1930.



Patent Specification)

"In carrying out our method the edges of the plate or plates to be welded are first chamfered and then brought into an abutting position to form a U or V-shaped groove along the line of weld. The plate or plates are then positioned over a suitable backing up bar standard welding apparatus and clamped in their abutted position. The groove is then filled with a powdered flux composition having a percentage of ground or powdered scale (ferrous oxide) to make the flux magnetizable.

"After the groove has been filled with flux the welding head of the welding machine, having a reel of welding rod or electrode wire thereon, is started in operation to feed the electrode down into welding position with respect to the flux filled groove and also to feed the electrode longitudinally of the groove. After the electrode is brought into proper position an arc will be struck so as to melt the flux in the groove and also to melt the metal of the electrode so as to furnish a deposit of metal in the groove.

"As the welding operation progresses the welding rod will be continually melted and deposit the molten metal through the molten flux in the groove, and the metal being of greater specific gravity than the molten flux will cause the flux to rise in the groove as the metal is deposited. The movement of the welding head is so timed that the proper amount of molten metal will be deposited to fill the groove the desired amount at the head passes along the groove.

"In carrying out this method the molten metal deposited from the electrode is at all times covered by a layer of the flux in the form of a slag and therefore the deposited metal from the electrode will remain molten a sufficient time to permit any entraining gases to escape and the deposited metal will not become oxidized since the flux or slag protects the molten metal from the atmosphere.

. . . . . .

"The operation of welding . . . may be carried out in several ways, all of which retain the one fundamental feature of maintaining a relatively heavy coating of flux or slag 9 on top of the molten welding metal and through which the molten metal is deposited so as to prevent oxidation of the metal.

. . . . . .

"In this modified method (illustrated above) the electrode 11 is caused to move down into the body of flux 9 and is then moved forward at a speed to maintain the electrode in close position relative to the flux, thereby causing said flux to be melted directly by the arc.

. . . . . .

"In the practice . . . of the above method a continuous electrode is used so that the welding operation may be carried on continuously as contrasted to the interrupted operations necessary when using the relatively short coated electrodes of the prior art."

The weld upon examination did not show any signs of rupture.

The pipe expanded from both ends was placed under a hammer and flattened out in the middle. The photograph below shows the pipe under hammer with the weld 90° to the force of the blow.

DEFENDANTS' EXHIBIT NO. 117-C.

DEFENDANTS' FXHIBIT NO. 141.

PROCESS OF PATENT IN SUIT
AS SHOWN & DESCRIBED IN JONES PATENT NO. 2,152,194

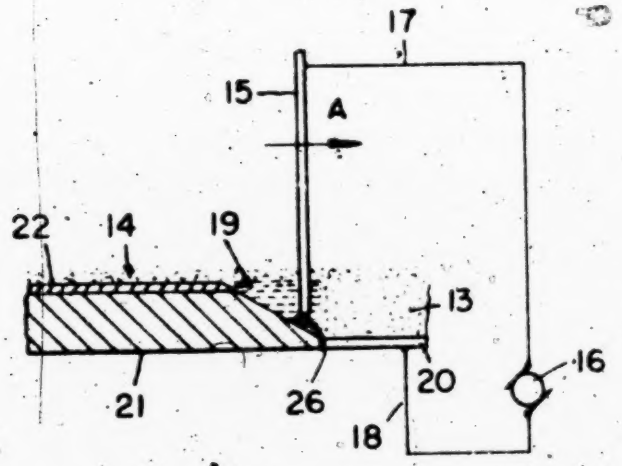


FIG 2.

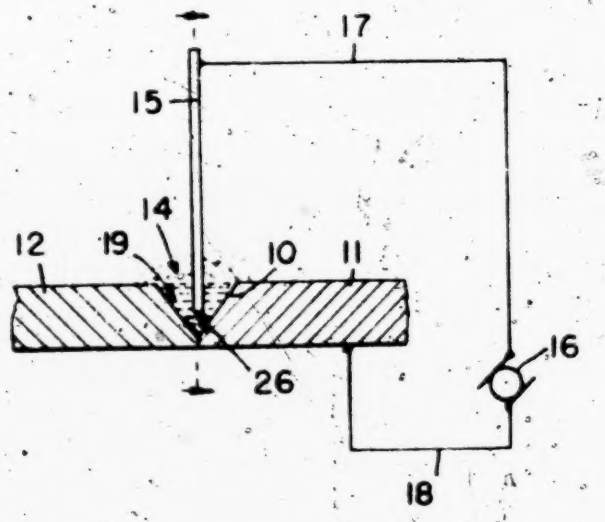


FIG 1

(Patent specification p. 1, col. 2, 11.)

"Referring to Figs. 1 and 2 which illustrate the process of electric welding disclosed in the patent (No. 2,043,960) referred to above, the groove or seam 10 formed between the opposing beveled edges of plates 11 and 12 adapted to be welded is filled with a high resistance welding composition 13 in powdered or granular form. Preferably an ample quantity of this material is used so that it forms a mound 14 extending lengthwise of the seam. An electrode 15 is inserted into the welding composition in the manner shown in Fig. 1, so that it is spaced from the plates 11 and 12. The welding circuit may comprise a source of electric energy 16 and conductors 17 and 18 connected to the electrode and work, respectively.

"In order to complete the welding circuit to start a welding operation, suitable material, such as steel wool, is provided to bridge the gap between the end of the electrode 15 and the plates 11 and 12. The flow of current between the electrode and the work heats a region of the welding composition 13 so that it fuses and becomes a high resistance conductive path, and this region of fused or liquid material supplies heat to fuse the end of the electrode 15 and the edges of the plates 11 and 12. The molten metal deposited from the electrode coalesces with the fused edges of the plates, and the fused material and molten metal occupy the entire space forming the welding zone.

"The electrode 15 is continuously fed toward the work and, after an interval of time, is moved along the seam 10 and through the welding composition or melt 13 at a uniform speed. At successive portions of the seam, the granular material 13 is locally fused and becomes highly fluid and superheated, as indicated at 19 in Fig. 2, whereby the liquid currents produced effectively mix the molten metal and welding composition to wash impurities out of the metal and separate the latter as it solidifies as an integral element of the plates being united. The progress of the welding operation is shown in Fig. 2 with the electrode 15 moving relatively to the work in the direction indicated by the arrow A. The welding composition 13 at the unwelded portion 20 of the seam ahead of the electrode 15 is in a powdered or granular state, while at the welded portion 21 of the seam the fused material has risen to the top of the weld and solidified, as shown at 22. In the welding operation just described, the excess amount of granular material, indicated at 14, remains unfused and covers the solidified layer 22."

(Id. p. 2, col. 1, l. 47)

". . . . . the welding zone 19 comprising highly fluid welding composition and fused metal."

(Id. p. 2, col. 1, l. 69)

"The lines of flow of current in the fluid welding composition and fused metal are indicated by the dotted lines 26, and extend downward and rearward of the electrode 15."

68 And afterwards, towit, on the 6th day of June, 1947, the following proceedings were had, towit:

And now the Court enters opinion, which opinion reads in the words and figures following, towit:

69 IN THE DISTRICT COURT OF THE UNITED STATES.

* * (Caption—607) * *

OPINION.

The first question to be decided in this case is: Did the patentees invent something patentable over the prior art of electric welding? If they did, two collateral questions arise: What constitutes their invention, and what are its boundaries?

The evidence on the first question is clear and convincing that Jones, Kennedy and Rotermund invented an important improvement in electric welding. Their method of welding differs vastly from electric-arc hand welding either of the bare rod or coated rod variety. Furthermore, an inventive-level difference exists between their method and the automatic welding method taught by Robinoff. The physical appearances surrounding the welding zone in the Jones, et al method of welding differ from those in any of the prior methods of electric-arc welding. In bare rod and coated rod hand welding, the electric arc creates a blinding glare, and there is a great amount of smoke and splatter. In the Robinoff clay flux method constant flashings occur, and the arc is always at least partially visible. While in contrast to the appearances of those methods, there is no glare, no open arc, no splatter, and
70 very little, if any, smoke in the Jones, et al. method.

The truly remarkable difference, however, between what Jones, Kennedy and Rotermund invented and what had gone on before is perhaps best manifested by the performance achievements of their invention. For instance, only through its use can plates as thick as two and one-half inches be welded in a single pass. Furthermore, the welding speeds made possible by it dwarf those of any other method, and the welds produced by it are of the highest quality in contrast to the great amount of porosity con-

tained in the welds produced by the so-called clay flux process.

Moreover, the commercial success of the Jones, et al method is persuasive evidence that this method is an improvement over the prior known methods. It is true that this commercial success has been confined principally to the sale and use of Unionmelt No. 20 in contradistinction to other possible compositions taught by the patent. However, testimony by users of Unionmelt that the Jones, et al method permits faster welding, saves costs and constitutes a vast improvement over hand welding is highly convincing that the method under inquiry is an invention.

Since the patentees did invent something patentable over the prior art of electric welding, the collateral questions of what constitutes their invention, and what are its boundaries, become pertinent.

To answer these questions a basic issue in this case must be decided. That issue is whether a fundamental difference in phenomena exists between the Jones, et al method and all methods of electric arc welding. If it could be said
71 without equivocation that the electric current passing between the electrode and the base metal travels through a welding composition which is in a melted or liquid state and that no "electric arc" is present, then a different electrical phenomenon would exist and a radically new process in electric welding would have been discovered. But no such finding can be made. The evidence is persuasive that no such basic difference in phenomena is present in the Jones, et al method.

The inventors themselves did not initially conceive their invention as embodying any such radical departure from known phenomena. Historically, they saw the Robinoff clay flux process in operation at the Western Pipe and Steel Company. It was from that point in welding development that they began their experiments with welding compositions which they hoped would give a better weld than was being obtained by the Robinoff process, which undoubtedly involves an electric arc phenomenon. During the course of their experiments, they did evolve a composition or compositions which produced better welds. The operational use of their welding composition was the same as the clay flux in the Robinoff process; that is, from a purely operational standpoint, there was and is no difference between the Robinoff and the Jones, et al methods. In both methods,

a deep layer of flux or welding composition is laid in the V formed by the beveled edges of the plates to be welded; a bare welding rod is fed down through this composition; and an electric current, which produces the heat to weld the plates, is conducted from the rod to the base metal. Thus, the physical operational steps in the two methods are identical.

72 In their first application for a patent, the patentees designated their invention as an "Improvement in Method of Electric Arc Welding and a Flux Therefor." The specification of this application is replete with references to the presence and use of an electric arc in the new method. It was only after they had assigned their rights in the invention to the plaintiff that the suggestion of a basically new kind of phenomena other than an arc began to be made.

When a deep layer of the patented welding composition is used, there is no visual evidence of an electric arc after the initial welding operation has begun. What actually occurs between the electrode and the base metal is hidden from view by the surrounding granular flux. Because one cannot see what is actually happening beneath the top layer of the flux in the normal welding operation, it is impossible to say with complete certainty that there is not an arc. Although some of the evidence submitted by the plaintiff indicates the presence of a phenomenon other than the electric arc, the plaintiff's expert witness, Dr. Doan, in effect admitted that the Jones, et al process involves an arc phenomenon. I am in accord with the following appraisal of his testimony stated in defendants' brief:

> "We submit that Dr. Doan's answers to the Court's questions, when considered together with his last-quoted testimony, amply establishes the following facts. In hand welding with a metallic electrode, the arc is initiated in making contact between the end of the electrode and the plate. The arc is immediately established and the arc consists of an ionized gaseous medium through which the current flows with bare rod and no flux, ionized particles of the air participate in the conducting gaseous medium, and are not conducive to the production of sound weld metal. With the coated electrode, however, any initial and momentary participation of air particles is immediately replaced by the coating of the electrode in ionized vapor state and

73 thereby the air is excluded, resulting in the production of sound metal. Dr. Doan admits that this produces an arc of entirely different characteristics. Yet it is still an arc. The only difference between it and the unshielded arc is the result of the coating on the electrode providing the shielding means. Identically the same thing takes place under a deep layer of flux. When the arc is initially established before the flux is vaporized, some air particles are present in the ionized gaseous medium. Immediately, however, the flux becomes vaporized, participates in and surrounds the arc zone, and shielding takes place to produce sound weld metal. Yet Dr. Doan claims this is not the same arc that was initially established. Neither is it the case of the hand electrode, but in both cases it is still an arc and as such conducts the current from electrode to plate, and provides the requisite heat for the welding operation."

In addition to his oral testimony regarding the existence of an arc, Dr. Doan made this significant statement in his treatise entitled, "Conduction of Electric Current in an Ionized Gas or Liquid:"

> "In the welding process of the Jones et al patent the welding rod is negative and the plate positive (or vice versa) with the pool of fused composition between them. All of the pool is 'ionized.') Current thus flows throughout the pool between rod and plate. The concentration of heat is greatest at the center or core of the pool, and the composition there is vaporized. The ions and electrons there having greater freedom of movement, a larger proportion of the current is made up of their charges. But throughout the pool, both in its vaporous core and surrounding liquid mantle, the mechanism of current conduction is basically the same, viz.: a progression of positive ions in one direction and of negative ions and electrons in the other."

Finally, I do not understand the plaintiff to dispute the view that its process involves the existence of an arc phenomenon. In its reply brief this concessionary statement appears:

> "Second, the process of the patent—there is contact, and a vaporous core or arc is entirely sealed in; * *

> The fact is that (this) * * is directly within the teachings of the patent and it is the actual operation which takes place in the Unionmelt and Lincolnweld processes."

74 Granted then that an arc exists, the question remains whether it has different characteristics than the arcs employed in the processes taught by the prior art of electric welding. Considering the phenomenon *per se,* it would appear that the conduction of electric energy in an ionized element which is in a gaseous or vaporized state is common to all electric arcs. In that respect there is no difference between the arc in the Jones, et al. process and any other arc. The difference is not in phenomena but in the element or elements constituting the "ionized" area of the arc operation and surrounding it. In bare rod welding, the dominant element in and around the arc is air. In covered rod welding, the fluxing material at least partially replaces the air. In the Robinoff clay flux method it is again the flux which at least partially replaces the air. In the Jones, et al method, it appears that the vaporized area of ionization constituting the arc zone is entirely blanketed and shielded by a mantle of fused welding composition. It also appears that the arc area within this mantle is composed predominately of vaporous welding composition.

The plaintiff contends that the submergence of the tip of the welding rod in the pool of fused flux is the key feature of the invention; or as stated in the argument, the unique feature is the contact of the welding rod with the fused pool of flux. If by this contention is meant that between the end of the welding rod and the vaporous arc zone there is an area of fused flux, it is not sustained by the evidence. Plaintiff's exhibit 173 is sufficient contradiction.

What does seem evident is that the welding rod some-
75 where above its very end is in contact with, or rather is surrounded by, the pool of fused flux and that the arc zone, the vaporous ionized area between the end of the electrode and base metal, is sealed in by a sheath of molten flux in the form of a cap above the base metal and in part of this pool there is entwined fused molten metal. The positive and negative terminals of the electrode and the base plate are within this vaporous ionized area.

The distinctive characteristics of this arc zone, viz.: the dominant element making up the vaporous ionized area and the protective surrounding sheath of molten substance, can

be attributed only to the peculiar properties of the welding composition which is employed. The mechanical operational steps involved are identical with those used by Robinoff. Indeed, the patentees who started with the teachings of Robinoff merely sought an improved welding composition or flux to be used with his operational method. Their experiments dealt solely with welding composition and the type and amount of electric current to be used to effect their objective. They discovered what they sought—compositions which when employed in a welding operation taught by Robinoff give a vastly improved weld over Robinoff, which permit the welding of far thicker plates in a single pass and at a speed many times faster than attained by any prior known method, and which completely eliminate the splatter and blinding glare of the so-called open arc.

The collateral questions of what constitutes the invention and what are its boundaries have been answered only partially. The remaining part of these questions concern-
76 ing what the welding compositions discovered by the inventors were, must await answer in the discussions of the validity of the patent in issue and of the question of infringement.

However, before taking up those discussions another matter must be treated. The inventors having discovered a new and useful welding composition that can be used successfully with the mechanical operations taught by Robinoff, the question of whether they also invented a new process of welding arises. When considered on the level of the apparatus and the mechanical manipulations employed in the process, the Jones, et al. method is no different than that disclosed by Robinoff. Likewise, when considered from the standpoint of whether a new scientific principle or phenomenon is involved the Jones, et al method presents no new process. On the other hand, it does involve an arc phenomenon that is created in a different medium than that taught by Robinoff. It also involves an arc phenomenon that is encased in a mantle of molten flux as distinguished from the Robinoff method in which the arc is at best only partially sheathed in the clay flux. Accordingly, if the criteria for determining a new process are that it need not be limited to changes in physical operational manipulations nor be of such high order as to involve fundamental changes in physical phenomena, then a new process is in-

volved in this invention. Those, I believe are the criteria which the courts have used in determining the question of whether a new process has been discovered. The Supreme Court in *Cochane* v. *Deener*, 94 U. S. 780, 787, laid down this definition of a patentable process.

77 "A process is a mode of treatment of certain materials to produce a given result. It is an act, or a series of acts, performed upon the subject-matter to be transformed and reduced to a different state or thing. If new and useful, it is just as patentable as is a piece of machinery. In the language of the patent law, it is an art. The machinery pointed out as suitable to perform the process may or may not be new or patentable; whilst the process itself may be altogether new, and produce an entirely new result. The process requires that certain things should be done with certain substances, and in a certain order; but the tools to be used in doing this may be of secondary consequence."

The "certain substances," that is, the compositions used in the Jones, et al method, are different from those used in the Robinoff method. A new result ensues, to-wit: an arc operating in different surroundings. Therefore, a new process of welding has been discovered.

The preceding paragraphs have been devoted mainly to the expression of determinations regarding the invention itself. It now becomes necessary to construe the patent in light of those determinations.

It has been pointed out before that the patentees described initially their invention in terms of a new welding method, in which an arc process is involved. After their rights to a patent had been assigned, a change in theory of operation in the scientific principle sense began to be evolved. This shift of theory is quite evident from the three successive applications filed for this patent. The new theory advanced in the second and continued in the third application, but never unequivocably espoused, is that the electric current passing between the electrode and the base metal flows through a conductive melt, that is through the flux, while it is in a melted state, rather than through a vaporous or gaseous medium such as occurs in an arc phenomenon. The defendants suggest this

78 change in theory was evolved solely for patent coverage purposes. No direct finding to that effect can be made. However, it is significant that the idea of a radically

different scientific principle came not from the inventors, but from plaintiff's patent solicitors.

That the initial idea of the inventors i. e., that they had an improved method of "submerged" arc welding, was never completely abandoned is evident from both the patent and the applications for it. For example, the patent recites: "Several circumstances show clearly that our process does not depend on the formation of an arc of the *usual* type." (Emphasis supplied.) To like effect, the second application states:

> "Applicants' specification has been slightly amended where it discusses the theory of their process, and compares this process with prior arc processes. It is immaterial to the patentability of the invention whether applicants are able to give the correct theory or not, but it is their purpose to give the examiner the fullest information in their possession on this matter. It is difficult, if not impossible, to define an arc precisely, and applicants have contemplated the possibility that a definition may be framed in such terms as to embrace the phenomenon which occurs in their process. There can be no question, however, that there is no such arc involved in their process as occurs in every prior arc process, including that of Robinoff, et al."

The patent's specification contains a sufficient disclosure of the method of welding invented to enable persons "skilled in the art" to accomplish the objective by following the teachings outlined in it. This, in my opinion, is the test of this point of validity regardless of whether an erroneous theory of operation is advanced. As stated in *Westinghouse Electric Mfg. Co. v. Montgomery E. L. & P. Co.*, 153 F. 890, 901:

79

> "The fact that the patentee did not fully understand the principle upon which his invention operated, or that his instructions were capable of a construction which would render the patent impracticable and defeat its purposes, should not deprive him of the benefit of a meritorious invention, provided it appears, as is found in this case, that the patent sufficiently disclosed to those skilled in the art the cause of the previous defects and a new and useful discovery and invention, by means of which they might be successfully overcome. He is not to be deprived of the benefit of his invention because he may have been mistaken in his

> statement of the reasons why the result was secured or may have failed to correctly state the theory of their operation."

Specifically in regard to the validity of the claims in issue it first should be pointed out that claims 1, 3, 4, 7, 8, and 9 make no reference to the chemical constituents of the welding composition to be used in the novel process discovered by the patentees. It is evident that the welding composition discovered by the inventors is the heart of the invention. The specification, except for references to prior art and objectives, deals with the properties of and the method of preparing a new welding composition. Indeed, the patent recites, "The composition of the welding medium is of the utmost importance."

The welding compositions in these six process claims are described therein as follows: a "chemically stable fusible material having at welding temperatures substantially the fluidity and electrical conductivity of a fusible silicate," (Claim 1), "a fused nonmetallic material," (Claim 3), "a pool of nonmetallic material fused in situ," (Claim 4), "a finely divided unbonded nonmetallic material which is fusible at welding temperatures," (Claim 7), "bounded particles of a prefused solidified and ground material capable of refusion in situ and active when fused to cleanse the fused depositing metal of an electrode," (Claim 8), and a "pool of material fused in situ without substantial gas evolution, said fused material being electrically conductive and active to cleanse the fused metal of the electrode and the work," (Claim 9). Since these six claims make no reference in any manner to the identity of the composition except in these general terms, it is my view that they are too broad and indefinite. Therefore they are invalid because they do not comply with section 33 of Title 35 of the United States Code.

Process claims 5, 6, 11, 12, 13, 14, 15, 16 and 17 are invalid for another reason. The import of each of these claims is that the sole conductive medium through which the electric current passes from the electrode to the base metal is the welding composition which is in a molten state and that the electric arc phenomenon is not present. To make a claim for a welding process in which these erroneous ideas are incorporated is to stake out a process or means of welding which does not in point of fact exist within the invention. While a patent covering a meritori-

ous invention should not be struck down because the patentee has misconceived the scientific principle of his invention, the error cannot be overlooked when the misconception is embodied in the claim.

Claim 2 recites that the method of welding invented "comprises supplying an electric current * * substantially wholly through a pool of silicate fused in situ, without the formation of any substantial gas-conducted electric arc." This part of the claim implies that an arc other than a "substantial gas-conducted" one may be the means
81 wherein the heat or energy for the welding is generated. Such a construction might save Claim 2 except that its validity is further dependent upon the sufficiency of its description of the welding composition.

In view of what has just been said regarding process Claim 2, it now becomes appropriate to decide whether the composition claims in issue are properly and validly drawn so as to afford the inventors a reasonable scope of protection for the welding compositions invented and disclosed by them. In an early paragraph of their specification, the inventors state:

> "We have used calcium silicate and silicates of sodium, barium, iron, manganese, cobalt, magnesium, nickel, and aluminum, both in binary and ternary combinations, in various proportions. We have also used calcium titanate and various titano-silicates, these being used when it is desired to introduce titanium into the weld metal. While a number of these conductive welding compositions are more or less efficacious in our process, we prefer to use silicates of the alkaline earth metals, such as calcium silicate, and we also prefer to add to these silicates minor proportions of alumina and of a substance adapted to lower the melting point, for example, a halide salt."

Although in later paragraphs of the specification, the inventors point out that other materials such as borax and boric acid as fluxing agents and ferro manganese, ferrosilicon, ferrochromium, calcium molybdate, and carbon as materials inducible into the weld metal may be added to the welding composition, those materials are not essential to its successful operation but are simply optional to the accomplishment of functions other than the creation of a novel electric arc welding medium which is the essence of the invention under inquiry.

Despite defendants' arguments concerning the proper meaning of the clause "While a number of these con-
82 ductive welding compositions are more or less efficacious in our process," a fair construction of it is that the invention includes compositions of those silicates mentioned and that the inventors found a number of them will accomplish the objectives of the patent more effectively than others of the group.

The inventors further state in this paragraph of specification that they prefer to use "silicates of the alkaline earth metals such as calcium silicate," and, in the next paragraph of specification, that their welding composition preferably comprises as its principal ingredients "silica * * at least one basic constituent of an alkaline earth such as lime * * or magnesia * * or a mixture thereof, and alumina * *."

What is ordinarily meant by the alkaline earth metals are calcium, magnesium, barium and strontium. Two of these, lime (calcium oxide) and magnesia, are listed in the patent as preferred basic constituents. The patentees say that they have also used barium silicate, which fact is substantiated by Mr. Kennedy's oral testimony. The import of the evidence on this score is that barium can be substituted effectually for lime or magnesium in the composition taught by the inventors in their patent. It may be noted however that the use of barium silicate as a welding composition is not commercially feasible because of its prohibitive cost. Although strontium is neither mentioned in the patent nor in the experimental notes of the inventors, the oral evidence is to the effect that it likewise can be used effectually as a basic component in the novel welding composition. Accordingly, in the light of these foregoing
83 facts claims listing an alkaline earth metal silicate as a major constituent of the novel welding composition are valid if in other respects they meet the requirements of section 33 of Title 35, United States Code. It is my opinion that composition claims 18, 20, 22 and 23 meet those requirements and are valid claims.

Claim 27 reads in part, "A prefused electric welding composition which is conductive when molten * *." Although that claim designates alkaline earth metal silicates as the principal constituents of the composition, the inevitable impression given by the quoted language is that the electric current passes solely through the composition

while it is in a molten state. Accordingly, this claim is invalid for the same reasons mentioned in the discussion of process claims 5, 6, etc.

Neither claim 24 nor claim 26 is limited to alkaline earth metal silicates. The one claims a new fluxing material comprising "metallic silicate and calcium fluoride" and the other claims an electric welding composition consisting chiefly of "silicates." The evidence is clear and convincing that many silicates, even many metallic silicates, are inoperative as major constituents in a welding composition having for its objectives those stated in the patent. This central fact renders these broad claims invalid.

In its brief plaintiff asserts, " * * two claims (i. e., claims 24 and 26) make no reference to alkaline earth materials whatsoever, and must be construed specifically to cover all nine metallic silicates set forth in the specifications and their equivalents." The answer to this assertion is
84 found in *Aluminum Co. of America* v. *Thompson Products Co., Inc.*, 122 F. 2d 796, 798. There as here, the patent owner asked to have broad claims narrowed by judicial construction to the scope of the invention disclosed in the specification. On that point the Circuit Court of Appeals for the Sixth Circuit said:

> "It urges upon us the application of the rule that claims must be read and construed in the light of the specification and so liberally interpreted as to uphold and not destroy the right of the inventor in the substance of his invention. *Westinghouse E. & M. Co.* v. *Quackenbush*, 6 Cir., 53 F. 2d 632, and cases therein cited. We are of the opinion that the rule there applied is limited to claims that are ambiguous and so require construction, and is in no event applicable where it appears to be clear that the inventor sought a broader monopoly than would seem to be justified by his invention as he has described it. *Wm. B. Scaife & Sons Co.* v. *Falls City Woolen Mills*, 6 Cir., 209 F. 210; *Union Switch & Signal Co.* v. *Kodel Elec. & Mfg. Co.*, 6 Cir., 55 F. 2d 173; *In re Lowry, Cust. & Pat. App.*, 93 F. 2d 909; *Cf. Kalle & Co.* v. *Mulfazo Co.*, 6 Cir., 109 F. 2d 321. In the first of the cited cases the general rule is clearly stated to the effect that a claim which is capable both of broad and narrow construction in the light of the specification will be given that construction which sustains

the patent, but therein it is held that "where, from the specification or the history of the application or the language of the claim it is clear that the patentee intended to claim and the Patent Office intended to grant the broader monopoly which turns out to be invalid, the courts will not, for the arbitrary purpose of saving the claim, read into it a limitation which it does not have.

"The appellant would have us interpolate into the defeated claims of its patent a limitation upon the silicon content of the patented alloy not there expressed. Not only are the claims held to be invalid without ambiguity, but it would appear to be clear that the inventor intended to claim the broader and not the more limited monopoly."

What has just been said about claims 24 and 26 applies equally to process claim 2.

Inasmuch as claims 18, 20, 22 and 23 are valid, the question of infringement becomes pertinent. Essentially the accused welding composition comprises manganese silicate to which has been added a small amount of calcium fluoride. The following comparison between the Unionmelt and the Lincolnweld compositions was made by Dr. Willard:

"So we have here in one case (Unionmelt) a silicate of calcium and magnesium with a little aluminum, and with calcium fluoride, and in the case of Lincolnweld we have silicate of calcium and manganese with a little aluminum and calcium fluoride added."

The two compositions are identical in operation, and the same kind of weld is produced by them. The mechanical methods in which these compositions are employed are essentially similar. A fair construction of the evidence is that Lincolnweld 660 flux can be substituted for Unionmelt Grade 20 without any change in operation or result except that Lincolnweld composition induces a greater amount of manganese into the weld metal. It is clear then that for all practical purposes, manganese silicate can be efficiently and effectually substituted for calcium and magnesium silicates as the major constituent of the welding composition.

Although manganese in its bivalent form has some characteristics of an alkaline earth metal, it is not classed as such in chemical literature. Since the accused flux is com-

posed principally of manganese silicate, it does not literally infringe composition claims 18, 20, 22 and 23. Whether it actually infringes these claims depends upon what application is made of the doctrine of equivalents. In that connection, no determination need be made whether it is a known chemical fact *outside* the teachings of the patent that manganese is an equivalent of calcium or magnesium. In the patent the inventors state, "We have used calcium silicate and silicates of sodium, barium, iron, manganese, cobalt, magnesium, nickel and aluminum, both in binary and
86 ternary combinations, in various proportions." Thus, the fact that manganese is a proper substitute for calcium silicate as a major ingredient of the welding composition invented by Jones, Kennedy and Rotermund is fully disclosed in the specification of their patent. The defendants have urged a construction that would have the sentence in question read, "We have used calcium silicate *with* or *plus* silicates of sodium, etc." It is my view that the correct construction of the sentence is, "We have used calcium silicate and *also* silicates of sodium, etc." That this is the correct view is borne out by the first application. That document in part recites: "* * * and there are other materials suitable to form the main body of the flux. Magnesium silicate, manganese silicate or these in combination serve admirably. * * * Particular fluxes that we have used are as follows: * * * (2) manganese silicate $MNO.SiO_2$ * * *." Accordingly, it is concluded that the patent itself fully discloses that welding compositions composed chiefly of manganese silicate and prepared according to the teachings of the patent are equivalent to those in which the alkaline earth metals are the principal constituents.

In this connection, the lack of any evidence of independent research or experiments by the Lincoln Electric Company in originating Lincolnweld 660 flux creates an inference that the teaching of the patent in suit was the sole origin of that composition.

The defendants contend that if it be determined that the Lincolnweld composition containing a major proportion of manganese silicate infringes any of the composition claims in issue, such claims have been completely anticipated
87 by Miller Patents Nos. 1,741,031, 1, 748,785 and 1,754,566, particularly the latter, which teaches the use of a manganese silicate coating in electric welding. But that Miller patent did not teach all that the Jones, et al. patent

does concerning an improved composition suitable for the welding method discovered by Robinoff. For example, that Miller patent reads in part:

> "Instead of preformed manganese silicate the coating may contain material adapted to react at the temperature of the metal-depositing operation to produce manganese silicate. This is the preferred form of the invention as it permits one operation to be dispensed with. The coating may contain for example an oxide ore of manganese and any finely divided form of silica. As in the case of the preformed silicate, the proportions may be such that $MnO.SiO_2$ or a more basic or acidic silicate will be formed."

The patent in suit requires that the acidic and the basic constituents of the composition be prefused or reacted, for it states as follows:

> "The chemical condition of the welding composition or medium is important: the acidic and basic constituents should be reacted, the composition should be substantially anhydrous and free from gases and all reactions should evolve deleterious amounts of gases during welding should be substantially completed, before the medium is used in the welding process."

Therefore, it cannot be said that the composition claims herein held valid are anticipated by the teachings of Miller.

The remaining issue in the case is the alleged misuse of the patent in suit by the plaintiff. The defendants contend that the plaintiff requires as a condition for a license that its licensees use unpatented weldrod furnished by it. In support of this contention typical forms of license agreements and rod purchase contracts used by the plaintiff were introduced into evidence. Although the license agreements are separate documents from the rod purchase con-
88 tracts, about ten percent of the existing license agreements and rod purchase contracts were executed on the same day by the licensee. Other documentary evidence indicates that the plaintiff instructs its sales force to avoid practices which could be interpreted by a prospective licensee as requiring him to execute a rod purchase contract as a condition of obtaining a license.

The defendants argue that the entire picture presented on this point indicates that a "tie in" requirement is imposed upon the licensee and that the plaintiff is doing by indirection what it may not do in a direct manner. This

inference for which the defendants contend is not buttressed by evidence that any licensee has actually felt compelled to sign a rod purchase contract as a condition of obtaining his license.

A patent owner may legitimately engage in selling unpatented material usable with the patented article or process licensed by him, but he cannot legally require the licensee to purchase such material from him as a part of the licensing arrangement. Unless it could be found that plaintiff's entire licensing conduct is merely a subterfuge, it is hard to conceive what more plaintiff could have done to safeguard itself from charges of having unduly broadened its patent monopoly. The evidence does not warrant a finding that the plaintiff's licensing conduct is a subterfuge. Therefore, it is concluded that the defendants have not met the burden of proving that the patent has been misused.

Findings of fact and conclusions of law in accord with this opinion are herewith being signed and entered.

89 Counsel for the plaintiff shall submit a form of judgment and decree in conformity with the conclusions of law to defendants' counsel within ten days and to the Court within fifteen days from date.

/s/ Luther M. Swygert,
Judge.

Hammond, Indiana,
June 6th, 1947.

90 And afterwards, towit, on the 6th day of June, 1947, the following proceedings were had, towit:

And now this action having been tried by the court without a jury, the court hereby makes the following findings of fact and conclusions of law, which finding of fact and conclusions of law read in the words and figures following, towit:

91 IN THE DISTRICT COURT OF THE UNITED STATES.

* * (Caption—607) * *

FINDINGS OF FACT AND CONCLUSIONS OF LAW.

This action having been tried by the court without a jury, the court hereby makes the following findings of fact and conclusions of law:

Findings of Fact.

1. This is an action for infringement of United States Letters Patent No. 2,043,960, issued to Union Carbide and Carbon Corp., a corporation of New York, on June 9, 1936, for improvements in Electric Welding, upon an application of Lloyd Theodore Jones, Harry Edward Kennedy and Maynard Arthur Rotermund, filed October 9, 1935, as a continuation-in-part of prior applications Serial Nos. 657,836 filed Feb. 21, 1933, and 705,892 filed Jan. 9, 1934.

2. Plaintiff The Linde Air Products Company is a corporation of Ohio, and by assignment has since June 10, 1936, and still is, the sole and exclusive owner of the entire right, title and interest in and to said patent.

3. Defendant The Lincoln Electric Company is a corporation of Ohio, and irrespective of any issue of jurisdiction, has openly assumed the defense of co-defendants Graver Tank & Mfg. Co., Inc., and Graver Tank & Mfg. Corp.

92 4. Defendant, Graver Tank & Mfg. Co., Inc., is a Delaware corporation. Defendant, Graver Tank & Mfg. Corp., is an Indiana corporation. The two Graver companies have a place of business within the Northern District of Indiana. It has been stipulated, solely for the

purposes of this present action, that no distinction need be made between the respective acts of Graver Tank & Mfg. Co., Inc., and Graver Tank & Mfg. Corp. in whatever proofs plaintiff may offer in support of its charge of infringement in this action, and that any judgment which is entered in this action shall apply in all respects to both as to injunctive relief, if any, and liability for accounting and award thereon, if any, to such two Graver companies, jointly and severally.

5. The motion picture (Plaintiff's Ex. 152) and the still photographs (Plaintiff's Exs. 153-157) fairly represent the appearance of the following welding demonstrations by plaintiff:

Demonstration No. 1—Bare rod hand welding;
Demonstration No. 2—coated rod hand welding;
Demonstration No. 3—automatic welding with Unionmelt;
Demonstration No. 4—automatic welding with Unionmelt in contrast with clay flux welding;
Demonstration No. 5—clay flux welding as practiced by National Tube Company and Western Pipe & Steel Company.

6. The clay flux composition used with the Robinoff process at the Western Pipe & Steel Company evolved a large volume of gas during welding. Jones et al. concluded that this gas caused the porosity in the clay flux welding. They determined they would avoid the evolution
93 of gas in the welding operation by developing a welding composition in which all reactions were entirely completed by prefusing at a high temperature.

7. Jones et al invented an improved welding composition usable in the operational method of electric welding taught by Robinoff. Their invention also included a novel welding process in the sense that the electric arc present between the electrode and base metal is sheathed by a mantle of molten welding composition and in that the conductive arc area is composed predominately of vaporous welding composition.

8. The performance capabilities of the invention represented an important advance in the welding art. These capabilities include:

a. Welding plates 2½ inches thick at a single pass;

b. employing electric currents of 3000 amperes and more;
c. attaining welding speeds of 120 inches or more per minute;
d. Producing welds of the highest quality.

9. Extensive commercial success has resulted from the exploitation of the invention by the plaintiff and its licensees. The welding composition principally used in attaining this success has been so-called Unionmelt 20 containing a major proportion of calcium silicate.

10. Compositions of calcium, magnesium, strontium and barium when prepared in accordance with the specification of the patent are operative as welding compositions within the teachings of the patent.

94 11. Calcium, magnesium, strontium and barium are the chemical elements which are known in chemical literature as the alkaline earth metals.

12. Manganese is not an alkaline earth metal.

13. Manganese silicate is one of the nine metallic silicates which the specification discloses that the inventors have used as principal constituents in welding compositions attaining more or less effectively the objectives of their invention.

14. The patent discloses that manganese silicate, when used as a principal constituent of a welding composition prepared according to the teachings of the patent, is a proper substitute for the silicates of the alkaline earth metals.

15. The composition of the welding medium is the essential feature of the invention. Process claims 1, 3, 4, 7, 8 and 9 make no specific reference to the chemical constituents of the welding composition to be used in the novel welding process which the patentees attempted to claim.

16. Process claims 5, 6, 11, 12, 13, 14, 15, 16 and 17 and composition claim 27 erroneously import that the sole conductive medium through which the electric current passes from the electrode to the base metal is the welding composition which is in a molten state and that no electric arc phenomenon is present.

17. Composition claim 26 and process claim 2 use the generic term "silicates" in describing the welding composition invented by the patentees. Composition claim 24 uses the limited generic term "metallic silicate" in de-

scribing the composition. Many silicates, even many
95 metallic silicates, are inoperative as major constituents in a welding composition having for its objective those stated in the patent.

18. Defendant, The Lincoln Electric Company, prior to 1942, experimented with and prepared to exploit the accused Lincolnweld composition. The first commercial installation of the Lincolnweld composition was at the plant of the defendant Graver Companies in 1942, in East Chicago, within the Northern District of Indiana. The accused composition was used by all defendants at said plant. The Graver Companies are still using the Lincolnweld flux at said plant.

19. Defendant, The Lincoln Electric Company, has made, used and sold and continues to make, use and sell the accused Lincolnweld 660 flux.

20. The accused Lincolnweld flux and the composition of the patent in suit are substantially identical in operation and in result.

21. The accused Lincolnweld 660 flux is a calcium manganese aluminum silicate with calcium fluoride added, which in welding operation is in all respects equivalent to the compositions of the patent in suit. Said flux contains:

Constituent	Per Cent (by weight)
CaO	2.66
MnO	48.19
SiO_2	40.30
Al_2O_3	1.88
Fe_2O_3	1.33
CaF_2	3.92
96 TiO_2	0.10
MgO	0.60
BaO	0.87
S	0.02

22. A person skilled in the art can produce the accused Lincolnweld 660 flux by following the teaching of the patent in suit. No evidence was introduced to show that the accused flux was derived from the prior art or by independent experiment, or from any source other than the teachings of the patent in suit.

23. In the Lincolnweld 660 flux the slight excess of basic oxide over stoichiometric proportions does not substan-

tially affect its operative character and follows the teaching of the patent.

24. The patent in suit teaches the substitution of manganese for other basic oxides and is not limited to the use of a moderate amount of manganese in addition to other basic oxides.

25. Composition claims 18, 20, 22 and 23 of the patent define invention of the prior art relied on by defendants.

26. Prior automatic electric welding processes and particularly in the Robinoff Process as commercially practiced by National Tube Co., at McKeesport, Pa., and by Western Pipe & Steel Co., at San Francisco, Calif., the following procedural steps have been employed:

(a) The plates to be welded are arranged with abutting edges which are beveled so as to form a V-shaped groove.

(b) Means for backing up the seam during welding are provided.

97 (c) The groove thus formed is filled with a welding composition in powdered or granular form.

(d) A mechanical device in the form of a welding head is mounted so as to be movable along the seam, such head including an automatic electrode feeding device whereby the electrode in the form of a rod or wire is drawn from a reel and fed toward the plates or workpieces as the head thus moves along the seam.

(e) The welding operation is initiated by inserting the end of such electrode or wire into the welding composition, striking an arc, and then applying the power.

27. The procedural steps followed in the welding process taught by the patent are identical in all respects with those followed in prior automatic electric welding processes and particularly in such Robinoff Process, and the only novelty presented by the process of the patent resides in the use of a different welding composition in the carrying out of such procedural steps.

28. Plaintiff does not impose as a condition of a license under the patent in suit, nor does plaintiff otherwise impose on its licensees, any requirement, condition, agreement or understanding as to the purchase or use of any goods, wares, merchandise, machinery, supplies or other commodities; and the licensees are free to buy and use any materials and equipment from any source.

98 Conclusions of Law.

1. This Court has jurisdiction of the parties hereto and of the subject matter of this cause.

2. Claims 18, 20, 22 and 23 of the Jones et al patent No. 2,043,960 are valid.

3. Claims 1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14, 15, 16, 17, 24, 26, and 27 of the Jones, et al, patent No. 2,043,960 are invalid.

4. The defendants and each of them have infringed each of claims 18, 20, 22 and 23.

5. The plaintiff has not been guilty of inequitable conduct and has not come into Court with unclean hands and is not barred from obtaining equitable relief.

6. Plaintiff is entitled to a permanent injunction against future infringement and threats of infringement of each of claims 18, 20, 22 and 23 of the Jones, et al, patent by each of the defendants and those controlled by any of them, and to an accounting for profits and damages, and to an assessment of costs against the defendants.

The Opinion filed herein shall be considered a part of these findings of fact and conclusions of law.

Dated: June 6th, 1947.

Enter:

Luther M. Swygert,
Judge.

99 And afterwards, towit, on the 9th day of July, 1947, the following proceedings were had, towit:

And now the Court enters Interlocutory Decree, which Interlocutory Decree reads in the words and figures following, towit:

100 IN THE DISTRICT COURT OF THE UNITED STATES.

* * (Caption—607) * *

INTERLOCUTORY DECREE.

This cause having been brought on for trial beginning January 2, 1947, and having been fully heard on pleadings, proofs, and arguments, witnesses in behalf of each party having been examined in the presence of the Court, and the cause having been duly considered;

It is hereby ordered, adjudged and decreed

(1) That the equities are with the plaintiff;

(2) That the Jones et al. patent in suit No. 2,043,960; issued June 9, 1936, is the property of the plaintiff, The Linde Air Products Company.

(3) That claims 18, 20, 22 and 23 of said Jones et al. Patent No. 2,043,960 are good and valid in law and have been infringed by defendants, Graver Tank & Mfg. Co., Inc., The Lincoln Electric Company, and Graver Tank & Mfg. Corp., and each of them;

(4) That claims 1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14, 15, 16, 17, 24, 26 and 27 of said Jones et al. Patent No. 2,043,960 in suit are invalid and void;

101 (5) That a permanent injunction be issued enjoining for the full term of said patent said defendants and each of them, their respective officers, agents, servants, employees, attorneys, and those controlled by any of them, from making, using, advertising or selling Lincolnweld 660 flux or any other welding composition or flux covered by any of claims 18, 20, 22 and 23 of said Patent No. 2,043,960, or offering so to do, aiding or abetting or in any way inducing infringement of said claims 18, 20, 22 and 23, or otherwise trespassing or infringing upon the same;

(6) That defendants report to the Court all Lincolnweld 660 flux in the possession of the defendants or any of

them, as of the date of final decree herein, and further report any disposition of such flux thereafter;

(7) That plaintiff recover from the defendants, and each of them, general damages which shall be due compensation for making, using or selling the invention, not less than a reasonable royalty therefor, together with such costs, interest, and attorneys fees if any, as may be fixed by the Court upon entry of a final decree herein;

(8) That this case be and the same is hereby referred to a Special Master to be hereafter appointed, to take and state an account of such general damages, so recoverable by the plaintiff and data on which to base calculation of interest on such damages, if any;

(9) That, defendants have advised of their intention to file notice of appeal immediately after entry of this decree, the issuance of an injunction and any accounting proceedings as hereinabove directed shall be suspended for a period of five (5) days from the date hereof and thereafter during the pendency of any appeal which may be taken
102 by defendants from this decree; such suspension beyond such five (5) day period being conditioned on the posting by said defendants, or any of them, of a supersedeas bond in the amount of Three Hundred Thousand Dollars ($300,000.00) in form and with surety or sureties to be approved by this Court, or in lieu of a surety such bond may be secured by the deposit in the Registry of this Court of bonds or other obligations of the United States Government having an aggregate face value of equal amount.

Dated: July 9, 1947.

(Sgd.) Swygert,
United States District Judge.

Approved as to form:
Richard Russell Wolfe,
Attorney for Plaintiff.

James R. Stewart,
Attorney for Defendants.

103 And afterwards, to wit, on the 9th day of July, 1947, the following proceedings were had, to wit:

Comes now the plaintiff and files notice of appeal, which notice reads in the words and figures following, to wit:

104 IN THE DISTRICT COURT OF THE UNITED STATES

For the Northern District of Indiana,

Hammond Division.

The Linde Air Products Company, *Plaintiff*, *vs.* Graver Tank & Mfg. Co., Inc., The Lincoln Electric Company, and Graver Tank & Mfg. Corp., *Defendants.*	Civil Action No. 607.

NOTICE OF APPEAL TO THE CIRCUIT COURT OF APPEALS FOR THE SEVENTH CIRCUIT, UNDER RULE 73(b) OF THE FEDERAL RULES OF CIVIL PROCEDURE.

Notice is hereby given that The Linde Air Products Company, plaintiff above named, hereby appeals to the Circuit Court of Appeals for the Seventh Circuit from that part of the interlocutory decree entered in this action on July 9, 1947, ordering, adjudging and decreeing that claims 1, 2, 3, 4, 6, 7, 8, 9, 11, 12, 13, 14, 15, 16, 17, 24, 26 and 27 of the Jones et al. patent No. 2,043,960 in suit are invalid and void. This appeal is taken under Sections 128 and 129 of the Judicial Code, 28 U. S. C., sections 225(b), 227 and 227(a).

Richard Russell Wolfe,
Carlson, Pitzner, Hubbard & Wolfe,
Attorneys for Plaintiff-Appellant,
The Linde Air Products Company.

Dated: July 9, 1947.

Acknowledgment is hereby made of the receipt of a copy of the foregoing notice this 9th day of July, 1947.

James R. Stewart,
Attorney for Defendants.

105 And afterwards, to wit, on the 6th day of October, 1947, the following proceedings were had, to wit:

Comes now the plaintiff and files statement of points on its appeal, which statement of points reads in the words and figures following to wit:

106 IN THE DISTRICT COURT OF THE UNITED STATES.

* * (Caption—607) * *

PLAINTIFF'S STATEMENT OF POINTS ON ITS APPEAL.

(Filed Oct. 6, 1947.)

The Linde Air Products Company hereby states that the following are the points involved on its appeal from the judgment on its complaint herein:

1. The Court erred as a matter of law in sustaining defendants' objection to the admission in evidence of plaintiff's exhibits for identification 232-A, B, C and D, and plaintiff's exhibits for identification 233-A and B as to which ruling the pertinent extracts from the transcript of testimony are set forth in Annex 1.

2. The Court erred in not finding and concluding that claims 1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14, 15, 16, 17, 24, 26 and 27 of the Jones et al. Patent in suit No. 2,043,960 issued June 9, 1936 are good and valid in law.

3. The Court erred in not concluding as a matter of law that plaintiff is entitled to a permanent injunction against future infringement and threats of infringement of

107 each of claims 1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14, 15, 16, 17, 24, 26 and 27 of said Jones et al. Patent No. 2,043,960 by each of the defendants and those controlled by any of them, and to an accounting for profits and damages for past infringement of each of said claims.

Carlson, Pitzner, Hubbard & Wolfe,
Attorneys for Plaintiff.

Receipt of a copy of the foregoing Statement of Points is hereby acknowledged this 3rd day of October, 1947.

Chas. L. Byron,
Attorney for Defendants.

108 ANNEX 1.

Excerpts from Testimony of EDWIN A. CLAPP, Transcript of Testimony, pp. 2293 through 2298:

"Q. You received, did you, the barium and strontium welding compositions that Mr. Brennan mentioned?

A. Yes, I did.

Q. Did you make test welds with them?

A. I did.

Q. Do you have the test welds with you?

A. Yes; the test welds are here in the court room.

Q. Will you state the welding conditions under which those were made?

A. They were made in half-inch plate—

Mr. Oberlin: If the Court please, we object to any further reference to this composition to which the question refers. Any welds made with them are improper rebuttal and have no bearing whatever." (pp. 2293-2294.)

* * * * *

"The Court: As I understand it, you are introducing this in the nature of corroborative evidence of testimony given by plaintiff's witnesses on cross-examination?

Mr. Wolfe: That is right.

The Court: In their main case?

Mr. Wolfe: That is correct.

109 Mr. Oberlin: The testimony of those witnesses merely elicited their knowledge of the possibility of making such welds. That was all that testimony was directed to.

The Court: If it is merely in corroboration, it stands uncontradicted.

Mr. Oberlin: It is certainly not proper rebuttal.

Mr. Wolfe: I think that there was no contradiction—at least, it doesn't occur to me at the moment—at any particular spot in the record.

Perhaps the defendants are willing to state now that there is no contradiction of Dr. Willard's testimony.

Mr. Byron: We are not going to make any such statement.

Mr. Oberlin: That was gone into on either the direct or cross-examination of Dr. Willard.

Mr. Wolfe: That was the occasion when Mr. Oberlin

wanted to know if he would stake his professional reputation on the possibility of making a weld.

The Court: Unless there is some rule of law, from the standpoint of time or surprise or not being prepared to submit the evidence, in that it was not foreseeable in 110 advance, it seems to me this is not within the realm of rebuttal evidence.

Mr. Wolfe: I think we must properly rely on your Honor's discretion to permit it here, in view of the time element.

The Court: I haven't heard your views on the objections, so I will withhold my ruling until I have heard those.

Mr. Oberlin: As stated, I think it is not proper rebuttal testimony, and admittedly is not rebuttal of any evidence produced in defendants' case.

The testimony just sought to be supported apparently is testimony given in plaintiff's prima facie case, and evidently they didn't think it necessary to produce any testimony there for us to meet, if that was required.

The Court: As I understand, it wasn't in existence at that time.

Mr. Wolfe: No, it wasn't. We had to make the flux and make the weld from the flux.

Mr. Oberlin: As I stated, the testimony, as I recall it, related wholly to the then knowledge of Dr. Willard, the witness, as to the efficacy of these fluxes for welding purposes. That couldn't be supported by any evidence 111 these other witnesses could give without their experimentations.

The Court: In the absence of any testimony in refutation, or the opening up of this subject by defense witnesses, I will sustain the objection.

Mr. Wolfe: May we have these exhibits marked for identification, the samples of the flux which were used and the sample plates.

The four samples of flux, those will be 232-A, B, C and D, and the two plates 233-A and B.

(Whereupon said articles were marked Plaintiff's Exhibits 232-A to D and 233-A and B for identification.)

Mr. Wolfe: And I would like to make a formal offer of those in evidence; and I suppose the ruling will be the same.

The Court: The record will show they are offered, and the offer denied and the objection sustained." (pp. 2295-2298.)

112 And afterwards, to wit, on the 9th day of July, 1947, the following proceedings were had, to wit:

Come now the defendants, and file notice of appeal, which notice of appeal read in the words and figures following, to wit:

113 IN THE DISTRICT COURT OF THE UNITED STATES

For the Northern District of Indiana,

Hammond Division.

The Linde Air Products Company, *Plaintiff*,

vs.

Graver Tank & Mfg. Co., Inc., The Lincoln Electric Company, and Graver Tank & Mfg. Corp., *Defendants.*

Civil Action No. 607.

NOTICE OF APPEAL.

Notice is hereby given that Graver Tank & Mfg. Co., Inc., The Lincoln Electric Company and Graver Tank & Mfg. Corporation, the above-named defendants, do hereby jointly and severally appeal to the Circuit Court of Appeals for the Seventh Circuit from the interlocutory decree entered in this action on June ....., 1947, insofar as said decree holds that claims 18, 20, 22 and 23 of the Jones et al. patent No. 2,043,960 in suit are good and valid in law and have been infringed by said defendants, and particularly from paragraphs No. 1, 3, 5, 6, 7 and 8 of said decree.

Graver Tank & Mfg. Co., Inc., The Lincoln Electric Company, Graver Tank & Mfg. Corporation,
By L. L. Bamberger,
Their Attorney.

July 9, 1947.

Service of the foregoing Notice of Appeal is hereby acknowledged, this 9th day of July, 1947.

Richard Russell Wolfe,
Attorney for Plaintiff.

114 And afterwards, to wit, on the 6th day of October, 1947, the following proceedings were had, to wit:

Come now the defendants-appellants and file statement of points, which statement of points read in the words and figures following, to wit:

115 IN THE DISTRICT COURT OF THE UNITED STATES.

* * (Caption—607) * *

STATEMENT OF POINTS BY DEFENDANTS APPELLANTS.

(Filed Oct. 6, 1947.)

Defendants, Graver Tank & Mfg. Co., Inc., The Lincoln Electric Company and Graver Tank & Mfg. Corporation, having heretofore under date of July 9, 1947, filed notice of appeal to the Circuit Court of Appeals for the Seventh Circuit from certain designated portions and provisions of the Interlocutory Appeal entered herein under the same date, in compliance with Rule 9 of said Court of Appeals, set forth herewith the errors of the District Court which said defendants-appellants assert and intend to urge on their appeal, viz.:

1. The District Court erred in holding and ruling in said decree:

(a) That the equities are with the plaintiff;

(b) That claims 18, 20, 22 and 23 of said Jones et al. Patent No. 2,043,960 are good and valid in law and have been infringed by defendants, Graver Tank & Mfg. Co., Inc., The Lincoln Electric Company, and Graver Tank & Mfg. Corp., and each of them;

(c) That a permanent injunction be issued enjoining for the full term of said patent said defendants and each of them, their respective officers, agents, servants, em-

116 ployees, attorneys, and those controlled by any of them, from making, using, advertising or selling Lincolnweld 660 flux or any other welding composition or flux covered by any of claims 18, 20, 22 and 23 of said Patent No. 2,043,960, or offering so to do, aiding or abetting or in any way inducing infringement of said claims, 18, 20, 22 and 23, or otherwise trespassing or infringing upon the same;

(d) That defendants report to the Court all Lincolnweld 660 flux in the possession of the defendants or any of them, as of the date of final decree herein, and further report any disposition of such flux thereafter;

(e) That plaintiff recover from the defendants, and each of them, general damages which shall be due compensation for making; using or selling the invention, not less than a reasonable royalty therefor, together with such costs, interest, and attorneys fees if any, as may be fixed by the Court upon entry of a final decree herein;

(f) That this case be and the same is hereby referred to a special master to be hereafter appointed to take and state an account of such general damages, so recoverable by the plaintiff and data on which to base calculation of interest on such damages, if any;

(2) That the District Court erred in not holding and ruling in said decree:

(a) That the equities are with the defendants.

(b) That claims 18, 20, 22 and 23 of said Jones et al. Patent No. 2,043,960 are invalid and void.

(c) That claims 18, 20, 22 and 23 of said Jones et al. patent, if valid, have not been infringed by defendants or any of them.

(d) That this action be and hereby is dismissed at plaintiff's costs.

117 3. That the District Court erred in making the following findings and conclusions, viz.:

(a) Compositions of calcium, magnesium, strontium and barium when prepared in accordance with the specification of the patent are operative as welding compositions within the teachings of the patent. (Finding 10.)

(b) Manganese silicate is one of the nine metallic silicates which the specification discloses that the inventors have used as principal constituents in welding compositions attaining more or less effectively the objectives of their invention. (Finding 13.)

(c) The patent discloses that manganese silicate, when used as a principal constituent of a welding composition prepared according to the teachings of the patent, is a proper substitute for the silicates of the alkaline earth metals. (Finding 14.)

(d) The accused Lincolnweld flux and the composition of the patent in suit are substantially identical in operation and in result. (Finding 20.)

(e) The accused Lincolnweld 660 flux is a calcium manganese aluminum silicate with calcium fluoride added, which in welding operation is in all respects equivalent to the compositions of the patent in suit. (Finding 21.)

118 (f) A person skilled in the art can produce the accused Lincolnweld 660 flux by following the teaching of the patent in suit. No evidence was introduced to show that the accused flux was derived from the prior art or by independent experiment, or from any source other than the teachings of the patent in suit. (Finding 22.)

(g) In the Lincolnweld 660 flux the slight excess of basic oxide over stoichiometric proportion does not substantially affect its operative character and follows the teaching of the patent. (Finding 23.)

(h) The patent in suit teaches the substitution of manganese for other basic oxides and is not limited to the use of a moderate amount of manganese in addition to other basic oxides. (Finding 24.)

(i) Composition claims 18, 20, 22 and 23 of the patent define invention over the prior art relied on by defendant. (Finding 25.)

(j) Plaintiff does not impose as a condition of a license under the patent in suit, nor does plaintiff otherwise impose on its licensees, any requirements, condition, agreement or understanding as to the purchase or use of any goods, wares, merchandise, machinery, supplies or other commodities; and the licensees are free to buy and use any materials and equipment from any source. (Finding 28.)

(k) Claims 18, 20, 22 and 23 of the Jones, et al. patent No. 2,043,960 are valid. (Conclusion 2.)

(l) The defendants and each of claims 18, 20, 22 and 23. (Conclusion 4.)

(m) The plaintiff has not been guilty of inequitable conduct and has not come into Court with unclean hands and is not barred from obtaining equitable relief. (Conclusion 5.)

(n) Plaintiff is entitled to a permanent injunction against future infringement and threats of infringe-

119 ment of each of claims 18, 20, 22 and 23 of the Jones, et al. patent by each of the defendants and those controlled by any of them, and to an accounting for profits and damages, and to an assessment of costs against the defendants. (Conclusion 6.)

4. That the District Court erred in not making the

following findings and conclusions as proposed by defendants, viz.:

(a) Insofar as the patent in suit relates to a composition of matter, or fluxing material for use in electric welding, the only such compositions, as to which any specific teaching is afforded, are ones which contain a major proportion of calcium silicate or a mixture of calcium and magnesium silicates, and which are properly defined only in claims not here in issue.

(b) While plaintiff's Unionmelt No. 20 flux corresponds with the composition thus taught by the patent, the latter fails to disclose the fact, shown by the record herein, that from the beginning of its exploitation of such Unionmelt flux, plaintiff has had to use therewith an electrode, or weld rod, containing from 1% to 2% of manganese metal, in order to obtain satisfactory welds.

(c) The patent in suit does not teach the substitution of manganese silicate for such calcium silicate, as the major constituent in such composition or fluxing material.

(d) The only teaching of the patent relative to the addition of manganese silicate to such composition or fluxing material limits such addition (a) to use with calcium silicate in binary and ternary combinations, and (b) to use in a moderate amount.

(e) Defendants' Lincolnweld 660 flux is almost entirely manganese silicate, present in the form of a complex fluoxysilicate, and contains less than 2% of alumina occurring as an unavoidable impurity in one of the ingredients used.

120 (f) The class of silicates, and equally so that of metallic silicates, and that of alkaline earth silicates, respectively include many that are unsatisfactory for use in such composition or that require further test and experimentation in order to determine their availability. This is true irrespective of whether calcium fluoride in amount not stated, or alumina in from 1% to 8% be added.

(g) Manganese is not an alkaline earth metal, and manganese silicate therefore cannot be considered to be an alkaline earth silicate; nor is it an equivalent thereof.

(h) Manganese silicate, as the major constituent in a composition of matter or fluxing material for electric welding, functions differently from calcium silicate and produces superior results, in that such manganese silicate increases the content of manganese in the weld metal instead of decreasing such content as does calcium silicate.

(i) Each of the following prior United States patents discloses a welding composition or fluxing material in which the ingredients were prefused and so rendered incapable of evolving gases under welding conditions, viz.:

No. 720,300	Vervaet	Feb. 10, 1903
" 1,467,825	Armor	Sep. 11, 1923
" 1,741,031	Miller	Dec. 24, 1924
" 1,748,785	"	Feb. 25, 1930

(j) Specifically said Miller Patent No. 1,748,785 discloses such a prefused composition or material containing a major proportion of a metallic silicate, viz. sodium borosilicate, together with a fluoride.

(k) In addition to the foregoing patents, the prior United States Patent to Miller No. 1,754,566, dated April 15, 1930, specifically discloses preformed manganese silicate as the major constituent of a welding composition or fluxing material which may be used either as a coating on
121 welding rods or electrodes or in the form of a powder into which they may be dipped.

(l) Said Miller Patent No. 1,754,566 further teaches the desirability of adding to such manganese silicate an auxiliary flux of the class whereof calcium fluoride is an example.

(m) The composition claims of the patent here in issue do not define invention over the prior art relied on by defendants.

(n) All of the composition claims in issue are invalid because they are broader than the alleged invention and theretofore do not meet the requirements of sec. 4888 R. S.

(o) All of the composition claims in issue are invalid because they are too indefinite and therefore do not meet the requirements of sec. 4888 R. S.

(p) All of the composition claims in issue are invalid because the specification of the patent does not give a sufficiently "full, clear, concise and exact" written description of the alleged invention covered by said composition claims as required by sec. 4888 R. S.

(q) If the composition claims in issue can be interpreted to include manganese silicate as a major constituent, said claims are invalid because anticipated by Miller Patent No. 1,754,566.

(r) All of the composition claims in issue are invalid.

(s) Of the composition claims in issue, claims 18, 20, 22, 23 and 27 are not infringed by defendants' flux, since the latter does not contain a major proportion of an alka-

line earth metal silicate as called for by each of said claims.

122 (t) Each of composition claims 24 and 26 in issue is invalid (a) as broader than the disclosure, (b) as covering silicates which are unsatisfactory in a composition or fluxing material for electric welding, (c) as requiring further tests and experimentation to determine the availability of particular members of the numerous class of silicates covered by said claims, respectively, and (d) as including many previously known compositions used in electric welding.

(u) In its exploitation of the patent in suit it has been the practice of the plaintiff to require customers purchasing the welding composition or fluxing material, e. g., Unionmelt 20 assertedly made under said patent, also to take out a license to practice the welding process in which such flux is employed (see Pltf. Exhs. 215 and 216-A to S). In many cases customers of plaintiff under these several forms of license agreement also entered into sales purchase contracts (Pltf. Exhs. 218 and 218-A to G) for weld rod to be used in connection with the process thus licensed; in about ten percent of such cases the date of execution of the license agreement and the rod contract is the same, although in some cases the actual execution may not have occurred simultaneously and such execution may have been by different individuals acting on behalf of the parties; and some such sales purchase contracts for weld rod were still outstanding and in effect following the filing of this action.

(v) Plaintiff has been guilty of inequitable conduct in its use of the patent in suit and has not come into court with clean hands and is therefore barred from equitable relief.

123 5. In rejecting from admission in evidence documents marked Defendants' Exhibits 109 and 110 for identification (see copies attached hereto) and further testimony of defendants' witness Boris Robinoff relating thereto; such testimony so far as given, together with the several objections and extended arguments of counsel, being fully set forth in the portions of the typewritten transcript to be included in the record on appeal herein and only excerpts of such record being herewith quoted, viz.:

(Trans. 1373, ll. 5-18)

Q. Now, Mr. Robinoff, did you prepare a description of what you believed was an improved method of electric

arc-welding, to be submitted to your superiors in National Tube?

A. Yes, I did.

Q. Did you write a letter to Mr. George A. Reuff, manager?

A. I did.

Q. Do you have a copy of that letter which you wrote?

A. I have.

Q. And will you read that?

Mr. Cahill: That I object to as a self-serving declaration. In this case we have the writer here.

(Trans. 1374, ll. 16-20)

Q. All right, then, Mr. Robinoff, will you tell us what you wrote in a letter to Mr. Reuff in connection with a description?

Mr. Cahill: I object to it because it is not material what he wrote.

(Trans. 1393, ll. 11-13)

The Court: Well, as I said, I am going to reserve my ruling on the matter. I will rule on it in the morning.

(Trans. 1394, ll. 1-9)

Q. Did you enclose something, when you wrote to Mr. Reuff?

A. I did.

Q. What was it?

Mr. Cahill: That I object to.

A. A description.

The Court: Just a moment. Just characterize it. Do not tell me what was in the letter?

The Witness: A description.

(Trans. 1397, ll. 17 to end)

Mr. Stewart: And I ask that the letter, which has not been offered, be marked as Defendants' Exhibit 109, and the two pages of enclosure as 110.

(Whereupon the said letter was marked Defendants' Exhibit 109 and the two pages of enclosure as Defendants' Exhibit 110 for identification.)

124 (Trans. 1531, l. 11 to 1532, l. 12)

Q. Now, Mr. Robinoff, in your cross-examination you were shown two letters which you wrote to Mr. Reuff relating to your attempt to get your patent. Yesterday I believe you testified that you did send a letter before 1929 as an initial effort to get your patent to your superiors, is that correct?

A. That is correct.

Q. And that letter with enclosure was yesterday identified as Defendants' Exhibits 108, 109 and 110. Was that the initial description—

A. Yes.

* * * * * *

Q. What was the first description of your invention submitted to your superiors?

A. That was the very beginning. Please let me see it.

Q. Will you look at all three of those and identify them, please.

A. That was the first time that I made acquainted our superiors, or my superiors, with what we had been doing, and asked them to obtain a patent.

Mr. Stewart: We offer that in evidence, your Honor.

(Trans. 1534, ll. 1-8)

Mr. Cahill: In order to save time, I will stipulate that I will not raise the objection on the fact of his absence or anything that goes to the authenticity, to the extent that the witness has heretofore identified the documents.

My objection goes to the substance, the essence of the testimony, not to any such identification as he has given.

(Trans. 1536, ll. 12-13)

The Court: (Continuing.) And the matter will still be reserved.

(Trans. 2083, ll. 19 et seq.)

The Court: * * * I have given consideration to the question having to do with certain exhibits. I do not have them in mind but they are the ones on which I reserved ruling.

Mr. Oberlin: Those were in connection with Mr. Robinoff's testimony. * * *

The Court: It seems to me, as to those exhibits which have to do with Mr. Robinoff's statements made and contained in these letters previous to the time of this application for an invention, that the only time they would be material would be on a question of conception, if that question were in issue in this case.

I am not saying that they would be admissible even under those circumstances, but it seems to me that that would be the only reasonable ground for their admission, because of their self-serving nature. It seems to me that as to when he conceived it—and not ruling as to what conception he had—is not in issue here because of the fact that the Robinoff patent preceded in date the patent in suit. Therefore, these documents are inadmissible in evidence because of their self-serving nature.

125 6. In refusing to permit, over the objection of plaintiff's counsel, plaintiff's witness Joseph Harrison Brennan to answer the following question on cross-examination, the re-statement of such objection and the extended arguments of counsel being fully set forth in the portions of the typewritten transcript to be included in the record on appeal herein, and only excerpts of such record being here quoted, viz.:

(Trans. 2286, ll. 6-13)

Q. Mr. Brennan, handing you a patent bearing the number 2,308,194 issued January 12, 1943, to Wilbur B. Miller, will you tell whether or not that patent includes in its coverage the specification of Unionmelt No. 90?

Mr. Cahill: That is objected to as already asked, and your Honor has sustained an objection to it.

(Trans. 2287, l. 2 from bottom to 2288, l. 7)

The Court: What is the purpose of this evidence?

Mr. Stewart: Your Honor, the purpose of this is to clarify one misleading point. This middle bottle down here (indicating) is put in as Unionmelt 90 as though it were in the patent in suit. I am only trying to bring out that it was the subject of a separate and later patent.

(Trans. 2290, ll. 10-16)

The Court: If it involves bringing in a patent, I will sustain the objection.

Mr. Oberlin: This is plaintiff's own patent.

The Court: If it brings in a new issue, I will sustain it. If you are going to show what it consists of, you may proceed.

Graver Tank & Mfg. Co., Inc.,
The Lincoln Electric Company,
Graver Tank & Mfg. Corp.,
Defendants-Appellants.
By L. L. Bomberger,
Their Attorney.

Of Counsel:
Chas. L. Byron,
Jno. F. Oberlin,
Ashley M. Van Duzer,
James R. Stewart.

Service of a copy of the foregoing Statement of Points by Defendants-Appellants acknowledged this 2nd day of October, 1947.

Richard Russell Wolfe,
Attorney for Plaintiff.

126 DEFENDANTS' EXHIBIT 109.

National Tube Company,
Christy Park Works,
McKeesport, Pa.
P. O. Box 421.

September 30, 1927.

Mr. Geo. A. Reuff, Manager,
O-f-f-i-c-e-

Dear Sir:—

Enclosed find a description of the improved methods of electric arc welding. Although we are not ready as yet to apply the methods as described above to production, we believe it would be advisable to patent the above methods as was suggested by Mr. G. P. McNiff, Assistant Vice President. We wish to point out that the idea of placing the metal refining and oxidizing compound in the groove where the welding takes place is novel, whereby the modifications as described can be questioned. However, we would like to see that we are not restricted in any of the methods mentioned, as we are not sure which of the described methods will give us best results.

Due to the fact that some of the modifications were suggested by different men, I would suggest these men as patentee:—B. Robinoff, S. E. Paine and W. Quillen.

Very truly yours,

Superintendent, Hammer Weld Department.

BH:VB
Encl.

127 DEFENDANTS' EXHIBIT 110.

National Tube Company,
Christy Park Works,
McKeesport, Pa.
P. O. Box 421.

(Written in pencil.) This description was submitted by Christy Parks Dept. B. Robinoff. See Svebet. H W 1121. This description was submitted to our lawyers when an application was made.

Description of Improved Methods of Electric Arc Welding.

1. It is a known fact that welds made by means of electric arc welding (carbon or metallic arc) are coarse in their structure, include large voids and show a lack of any appreciable elongation. Hitherto it was impossible to apply this method of welding to the process of manufacturing pipe or tanks, especially when the product of manufacture in its further conversion was subjected to the processes of bending, expansion, upsetting or reduction of its original section.

2. We found that protective coatings applied to rods hitherto by way of submersion the rods in milk of lime solution, or in aqueous solution of sodium silicate, or carbonate of lime does not remove the objections as described above, neither does the application of fluxes such as calcium, borium, strontium, ground asbestos, pulp or paper improve the welds in way which is essential in manufacturing of products subject to further processing like bending, finishing, upsetting.

3. The outstanding feature of metal deposited by means of an electric arc (carbon or metallic rod) as it is practiced today, is the presence of a large amount of combined oxygen and nitrogen which causes the presence of considerable amounts of oxides and nitrides sometimes constituting over 1% of metal deposited. The oxides and nitrides are finally intermixed with the molten metal and are the prime cause of hardness and brittleness which deprives the welds of desired ductility.

4. We have discovered a method of electric arc welding (carbon or metallic rod) whereby the welds produced possess qualities of ductility equal to and better than the parent metal.

A desoxidizing flux with qualities to refine the metal is deposited in heavy layers corresponding to the thickness of the plate to be welded, in and around the regions where the welding takes place. A metallic or carbon electrode are inserted in the flux to a certain depth, so that the arc produced and the metal deposited are under complete cover. The actual welding takes place in such a way that the rays of the electric arc disappear under cover, partially or altogether.

The metal desoxidizing and refining compound is transformed under action of the electric arc into a fluid slag which floats on top due to its specific gravity, while the metal being heavier than the slag, is deposited underneath. The slag which floats on top stays in molten condition for a considerable length of time preventing the rapid cooling of metal deposited.

See sketch No. 1.

128 5. The welding under heavy deposit of the metal desoxidizing and refining compound resembles the steel refining operation in electric furnaces, however the idea of joining two pieces of metal by means of welding under conditions as described above is novel.

6. The following modifications of the method as described above produce a similar results with certain graduations of the results obtained. A funnel shaped container placed around the metallic or carbon arc, arranged in such a way that a steady amount of metal desoxidizing and refining compound is deposited immediately in back of the molten metal deposited by metallic or arc, produces same results with certain modifications.

See sketch No. 2.

A flat bar or a round metallic rod as a core and metal desoxidizing and refining compound inserted between the bar or rod and paper as a jacket and put in place where the two pieces of metal are going to be jointed with an electric arc, (carbon only) producing the necessary heat, gives same results with certain modifications.

See sketch No. 3.

A spirally wound paper to be filled with same compound between the spirals and placed jacket-like over the metallic rod, which rod, while melting and depositing metal, covers at the same time the deposited metal with flux, produces same results with certain modifications.

See sketch No. 4.

7. Any electric metallic rod corresponding to specifications of A. W. S., or any alloy rod with certain desired elements in preponderance, can be used in the above described method of electric welding.

8. Welds produced in the aforesaid manner, withstand cold bending 180° and hammered flat, expansion and reduction of original dimensions of circular vessels, bending of circular vessels, show an absolute lack of porosity and a maximum strength of the joint.

9. The approximate chemical analysis of the metal desoxidizing and refining compound is as follows:

Silica	30%—40%
Alumina	7%—9%
Ferrous oxide	45%—55%
Lime	1/2%—1-1/2%
Magnesia	.10%—.20%
Loss of Ignition	2%—4%

The cost of the above compound is negligible and the application as described above is very simple as compared with other coated rods, where the cost of coated rods relates to cost of bare rods as 10:1.

10. We do not want to restrict ourselves to the quantities of the compound as shown above. The above material is used in a form of fine powder, preferably after grinding and drying operation.

129 And afterwards, towit, on the 12th day of July, 1947, the following proceedings were had, towit:

Come now the defendants and file appeal Supersedeas Bond, which Appeal Supersedeas Bond reads in the words and figures following, towit:

130 In the District Court of the United States.

* * (Caption—607) * *

APPEAL SUPERSEDEAS BOND.

Know All Men By These Presents that we, The Lincoln Electric Company, a corporation of Ohio, having its principal office and place of business at Cleveland in said State, are held and firmly bound unto The Linde Air Products

Company, likewise a corporation of Ohio, and having its principal office and place of business at Cleveland in said State, in the full and just sum of Three Hundred Thousand Dollars ($300,000) to be paid to the said The Linde Air Products Company, its attorneys, successors or assigns; to which payment well and truly to be made we bind ourselves, our successors and assigns, jointly and severally by these presents.

Sealed with our seal and dated this 11th day of July, in the year of our Lord, One Thousand Nine Hundred and Forty-seven.

131 Whereas, lately at a session of the District Court of the United States for the Northern District of Indiana, Hammond Division, in a suit pending in said Court between the said The Linde Air Products Company as plaintiff and the said The Lincoln Electric Company, together with Graver Tank & Mfg. Co., Inc., and Graver Tank & Mfg. Corp., as co-defendants, Civil Action No. 607, an interlocutory decree for injunction and accounting was rendered against the said defendants as to claims 18, 20, 22 and 23 of United States Letter Patent No. 2,043,960 to Jones et al, and the said defendants have filed notice of their appeal to the United States Circuit Court of Appeals for the Seventh Circuit to reverse said decree, and the said District Court has further ordered that said appeal shall operate as a supersedeas of said decree and shall suspend and stay all further proceedings in said District Court until the termination of said appeal by said Seventh Circuit Court of Appeals, conditioned upon the filing of a bond in the sum of Three Hundred Thousand Dollars ($300,000), all as more particularly set forth in said decree; and the said defendants-appellants desire to perfect such stay and give such bond, and have deposited in the Registry of said District Court certified check for Three Hundred Thousand Dollars ($300,000) as security, said check being drawn by the undersigned, The Lincoln Electric Company, made payable to the United States District Court (northern District of Indiana). Registry and certified by The Cleve-
132 land Trust Company, of Cleveland, Ohio, on July 11, 1947;

Now, Therefore, the Condition of the Above Obligation is such that if said defendants-appellants, or any of them, prosecute their appeal with effect and shall satisfy the judgment in full, together with costs, interest and damages for delay, if for any reason the appeal is dismissed or if

the judgment is affirmed, and shall satisfy in full such modification of the judgment and costs, interest and damages as said appellate court may adjudge and award, then this obligation to be void and the security deposited herewith shall be forthwith released; otherwise this obligation to remain in full force and effect.

Signed at Cleveland, Ohio, July 11th, 1947.

The Lincoln Electric Company,
By A. M. Taylor,
Executive Vice President.

The foregoing bond is hereby approved and is to stand as a supersedeas until the final determination of the appeal.

Luther M. Swygert,
U. S. District Judge.

July 14, 1947.

133 And afterwards, towit, on the 8th day of August, 1947, the following proceedings were had, towit:

Come now the parties herein and file stipulation extending time to file record on appeal, which stipulation reads in the words and figures following, towit:

134 IN THE UNITED STATES DISTRICT COURT.

* * (Caption—607) * *

STIPULATION EXTENDING TIME TO FILE RECORD ON APPEAL.

(Filed Aug. 8, 1947.)

It is stipulated and agreed by and between the attorneys for the respective parties, hereto, that, subject to the approval of this Court, the time of said parties to file a transcript of record on their respective appeals to the United States Circuit Court of Appeals for the Seventh Circuit shall be extended to and including September 17, 1947.

Carlson, Pitzner, Hubbard & Wolfe,
Attorneys for Plaintiff-Appellant.

Chas. L. Byron,
M. Bomberger,
Attorneys for Defendants-Appellants.

Dated August 5th, 1947.

135 And afterwards, towit, on the 8th day of August, 1947, the following proceedings were had, towit:

And now the Court enters order extending time to file record on appeal, which order reads in the words and figures following, towit:

136 IN THE UNITED STATES DISTRICT COURT.

* * (Caption—607) * *

ORDER EXTENDING TIME TO FILE RECORD.

(Filed Aug. 8, 1947.)

Pursuant to stipulation filed herein,

It Is Hereby Ordered that the time for filing and docketing the record on appeal, on the respective appeals of the parties hereto, pursuant to Rule 73(g) of the Federal Rules of Civil Procedure, be and the same is hereby extended to and including September 17, 1947.

Luther M. Swygert,

Dated August 7, 1947. *U. S. District Judge.*

137 And afterwards, towit, on the 16th day of September, 1947, the following proceedings were had, towit:

Come now the parties and file stipulation extending time to file record on appeal, which stipulation reads in the words and figures following, towit:

It is stipulated and agreed by and between the attorneys for the respective parties hereto, that, subject to the approval of this Court, the time of said parties to file a transcript of record on their respective appeals to the United States Circuit Court of Appeals for the Seventh Circuit shall be extended to and including October 7, 1947, the same being ninety (90) days from the first notice of appeal herein, which was filed on July 9, 1947.

Carlson, Pitzner, Hubbard & Wolfe,
Attorneys for Plaintiff-Appellant.
Charles L. Byron,
Attorney for Defendants-Appellants.

September 15, 1947.

And afterwards, towit, on the 17th day of September, 1947, the following proceedings were had, towit:

And now the Court enters order extending time to file record on appeal, which order reads in the words and figures following, towit:

138 On the stipulation heretofore filed that the time for filing the transcripts of record in said cause, shall be extended, it is hereby ordered that the time for filing the transcripts of record for both parties shall be and it is hereby extended to and including October 7, 1947.

Dated this 17th day of September, 1947.

Luther M. Swygert,
District Judge.

And afterwards, towit, on the 6th day of October, 1947, the following proceedings were had, towit:

Come now the parties and file stipulation as to record on appeal, which stipulation reads in the words and figures following, towit:

139 IN THE DISTRICT COURT OF THE UNITED STATES.

* * (Caption—607) * *

STIPULATION AS TO RECORD ON APPEAL

(Filed Oct. 6, 1947.)

It Is Hereby Stipulated and Agreed, by and between counsel for the respective parties to the above entitled cause, pursuant to the provisions of Rules 75(f) and 75(k) of the Federal Rules of Civil Procedure, that the record on appeal shall include:

1. The following pleadings and related papers:
   (a) The original complaint;
   (b) Separate answer of defendant The Lincoln Electric Company;
   (c) Separate answer of defendant Graver Tank & Mfg. Co., Inc.
   (d) Order entered March 16, 1946, adding defendant

Graver Tank & Mfg. Corp. and permitting service of amended complaint;

(e) Amended complaint;

(f) Pre-trial order;

(g) Defendants' notice pursuant to pre-trial order dated December 3, 1946;

(h) Defendants' notice pursuant to pre-trial order dated December 5, 1946.

140 2. The portions of the typewritten transcript of evidence and proceedings indicated on the attached copy thereof.

3. All exhibits admitted in evidence, together with Plaintiff's Exhibits 232A-D, 233A-B, and Defendants' Exhibits 109 and 110, each of which was excluded by the court. Said exhibits are to be transmitted and filed as follows:

(a) Documentary exhibits to be filed and printed as a part of the transcript of record:

Plaintiff's Exhibits 124, 128, 151, 158, 167, 173, 190, 191, 193 (photograph to be printed), 194 and 227; and

Defendants' Exhibits 101, 103, 108, 117-A, 117-B, 117-C, 119, 137, 139, 140, 141, and 145-D (Miller Patent No. 1,754,566).

(b) Original documentary exhibits not to be printed but to be filed with the transcript of record as physical exhibits:

Plaintiff's Exhibits 125, 126, 127, 147X-1, 147X-2, 148X-1, 148X-2, 149X-1, 149X-2, 153, 154, 155, 156, 157, 159, 160, 161, 162, 163, 175A-C, 178, 179, 182X-1, 182X-2, 183X-3, 188, 189A-W, 195, 196, 197, 199, 200, 201, 202, 203, 204A-J, 205, 206, 208, 209, 210, 211, 212, 214, 215, 216, 216A-B, 217, 218A-G, 219, 220, 222, 223, 224, 225, 226, 228, 229A-E, 230, 235, 236; and

Defendants' Exhibits 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 97A-C, 98A-Y, 99, 100, 102, 104-A, 120, 121, 121A-C, 123X, 126X, 128X, 131X, 134, 135, 136, 138, 142, 143, 144, 145, 146, 148, 109, 110.

(c) Original non-documentary exhibits to be filed with the transcript of record in accordance with Rule 10(6) of the Court of Appeals:

141 Plaintiff's Exhibits 129, 130, 131, 133A, 133B, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 152, 164, 165, 166,

168, 169, 170, 171, 172A, 172B, 174, 176, 177, 180, 181A, 181B, 182, 183, 184, 185, 186, 187A, 187B, 192, 193, 198, 207, 213, 231, 232A-D, 233A-B, 234; and

Defendants' Exhibits 106, 107, 112, 113, 114, 115, 116, 116A-E, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 149, 150, 151, 152, 153, 154, 155, 156, 157.

(d) Two additional copies of each of the following exhibits will be delivered by the respective parties, as indicated below, to the Clerk of the Circuit Court of Appeals for the Seventh Circuit on or before delivery of printed copies of the record on appeal, the cost of such copies to be considered taxable costs along with the amounts which the respective parties may pay for the printing of the record on appeal:

(1) By plaintiff: Plaintiff's Exhibits 125, 126, 127, 204A-J, and 236;

(2) By defendants: Plaintiff's Exhibit 203 and Defendants' Exhibits 142, 143, 144 and 145A-C.

4. Findings of Fact and Conclusions of Law, entered June 6, 1947.

5. Opinion, entered June 6, 1947.

6. Interlocutory decree, entered July 9, 1947.

7. Notice of appeal by plaintiff.

8. Notice of appeal by defendants.

9. Defendants' Appeal Supersedeas Bond.

10. Statement of points to be urged on its appeal by plaintiff-appellant, filed herewith.

11. Statement of points to be urged on their appeal by defendants-appellants, filed herewith.

142 12. This stipulation respecting the matter to be included in the record.

13. Any further stipulation between the parties hereto concerning the record on these appeals or the time for the docketing thereof and any and all orders of the Court with regard thereto.

Cahill, Gordon, Zachry & Reindel,
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Attorneys for Defendants.

Patented June 9, 1936 2,043,960

UNITED STATES PATENT OFFICE

2,043,960

ELECTRIC WELDING

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No Drawing. Application October 9, 1935, Serial No. 44,142

29 Claims. (Cl. 219—10)

This invention relates to electric welding.

Among the various ways in which electrical energy has been converted into heat for the welding of metals, the arc process (which itself takes several forms) is the one most generally practiced. A typical example of arc-welding is its use to join the abutting edges of steel plates. In the metal-arc variation of the arc process, molten metal, provided by the melting of a metal wire or rod of suitable composition, is introduced between the abutting edges of the plates, and the latter are fused sufficiently to permit the added metal to coalesce with the metal of the plates so that, on cooling, a structurally strong bond results. The requisite heat is developed, as the term "arc process" implies, by maintaining either a direct current or an alternating arc between the parts to be welded, connected to one side of the power line, and the wire or rod used to supply the molten metal, connected to the other side of the power line. The abutting plate edges are usually beveled to form a trough for receiving the molten metal, thereby facilitating coalescence of the added metal with the plates throughout the thickness of the latter.

The simplicity of bare wire-electrode welding recommends it above all other methods, but the metallurgical and physical properties of metal deposited in this simple manner are usually so poor that the method is unsuitable for many applications.

In order to avoid certain difficulties encountered in bare metal arc welding, it is customary to protect the freshly deposited molten metal with a blanket of molten metal compounds (usually compounds of the alkali or alkaline earth metals). The material used for forming this blanket is called the "flux" The usual method of providing a flux blanket on the weld is to encase the welding rod or wire (usually referred to as the electrode) in an adherent sheath of solid flux, and this gives rise to other difficulties. The sheath is usually fragile and, being nonmetallic in nature, is nonconductive when cold, so that electrical connection must be made with the electrode at points bared for that purpose at intervals at variable distances from the weld, thereby imposing an additional burden on the automatic regulating devices widely used in welding. When the bared sections reach the melting zone metal of inferior quality is deposited. The current must pass through a variable length of rod, the length between the arc and the contact point, heating it sufficiently to crack off the flux covering and further to add an IR-drop to the arc voltage. This IR-drop is not constant in magnitude but varies according to the position of the contact point relative to the arc. The machine, unable to discriminate between arc voltage and electrode drop, cannot maintain the constant arc length so necessary to successful welding unless compensatory means are resorted to. These difficulties therefore limit the energy which may be expended in the arc. We are not aware of current values in excess of about 500 amperes being used in this manner of welding.

For good welding a homogeneous deposit of metal is indispensable. In metal-arc welding it is found that the difficulties involved in securing a homogeneous deposit are multiplied as the thickness of the deposit increases, so that, if thick plates are to be welded, it becomes necessary to make several traverses or "passes", adding a layer of metal each time until the necessary thickness is attained. This method of operation is obviously time-consuming, the more so since it is usually necessary to chip off the cover of solidified flux on one deposit, and peen the metal, before another deposit can be superimposed. It also complicates the stresses set up by contraction of the metal in the cooling weld, and the resulting distortion of the welded parts.

There is another known means of applying protective flux. It consists in utilizing a thick coating of finely divided material, a flux, which covers the seam to be welded. The welding electrode, which is a bare wire of suitable composition, is fed down by conventional feeding means and the arc is struck under this powdered flux. The electrode is traversed at a contant rate along the path to be welded. Direct current is applied at a voltage of about 30 volts with a current up to about 900 amperes. The flux used in this system has been a natural clay of approximately the composition used in making brick. The following is a typical analysis of such a flux: 50.6% SiO_2; 18.86% Al_2O_3; 4.34% Fe_2O_3; 5.00% CaO; 6.00% Mn; 3.03% Fe. Although this method retains the advantage of feeding current continuously to a bare wire at a point adjacent to the weld, the weld metal deposited thereby is seriously deficient in quality. A weld made by this method may have ample strength for certain purposes, but it is so porous that it can hardly be said to be satisfactory. It is, therefore, customary to hand-weld on the bottom side to insure superficial freedom from holes. It has not been found possible to extend this method beyond ½ inch plate and there is no immunity from undesirable porosity in any thickness. Moreover, the vigor of the arc submerged under this flux projects a continuous cloud of material into the atmosphere. An evidence of the amount of gas that is emitted by a flux of this nature is afforded by the fact that the welders very frequently wear gas masks to protect themselves from the dust. Since the dust is thrown up by gas that is evolved from the flux and the weld metal, it is not surprising that gas holes should be found in the metal of the weld.

An object of the present invention is to avoid

the disadvantageous features cited above, and to provide a process by which even thick plates can be strongly and rapidly electrically welded, in a single pass or in a plurality of passes, with a weld of which the density and physical properties are at least equal to those of the parent metal. Another object is to provide a process in which heavier welding currents can be used and the rate of welding accelerated. A further object is to overcome the difficulties which, in prior processes, are caused by the inherent instability of an electric arc, its liability to be extinguished by a variety of adventitious causes, and the difficulty, especially in automatic machines, of reestablishing the arc when it has been extinguished. Another object is to avoid the necessity for a flux sheath on the electrode. Other objects of the invention will become apparent as the description of our invention proceeds.

We have discovered a novel process for electric welding wherein the necessary heat is generated by the passage of a heavy electric current between a metal electrode (usually bare) and the metal plates or similar objects to be welded, the electrode being out of mechanical contact with the objects and the current being carried across the gap between the electrode and the objects by and through a conductive melt or welding composition having appropriate electrical resistance properties. The heat thus generated melts successive portions of the electrode and the molten material is deposited as weld filler material. The welding composition serves as an active instrumentality, or welding medium, inasmuch as it provides heating means, controls the rate, penetration, and quality of welding, purifies the molten metal, and protects the molten metal.

A large number of experimental welds which we have made support the conclusion that the properties of a successful welding composition for this method of welding are these:

(1) The chemical reactions between the components of the welding composition must be completed before it is used in welding. Failure in this regard most surely invites porosity.

(2) It must be capable of controlling the penetration and the width of the weld.

(3) Its fluidity at welding temperatures must be such that it will not become entrained with the molten metal.

(4) It must consist of chemicals which are not detrimental to the properties of the steel, and

(5) It must be readily removable from the finished weld.

The composition of the welding medium is of the utmost importance. The particular composition that is to be used is determined by the quality and thickness of the metal plates to be welded, by the current and voltage to be used, and by the properties it is desired to impart to the weld metal.

We have used calcium silicate and silicates of sodium, barium, iron, manganese, cobalt, magnesium, nickel and aluminum, both in binary and ternary combinations, in various proportions. We have also used calcium titanate and various titano-silicates, these being used when it is desired to introduce titanium into the weld metal. While a number of these conductive welding compositions are more or less efficacious in our process, we prefer to use silicates of the alkaline earth metals, such as calcium silicate, and we also prefer to add to these silicates minor proportions of alumina and of a substance adapted to lower the melting point, for example, a halide salt.

More specifically, the welding composition preferably comprises, as its principal ingredients, silica (SiO_2), at least one basic constituent consisting of an alkaline earth such as lime (CaO) or magnesia (MgO) or a mixture thereof, and alumina (Al_2O_3). The silica and basic constituent are in approximately the proportions theoretically required to form metasilicates; although a substantial excess of silica is permissible and frequently advisable. For example, if the basic constituent is lime, the proportions by weight will be approximately 0.7 to 1 part of CaO to 1 part of SiO_2; and if magnesia is substituted for part or all of the lime, the silica is increased accordingly, so as to maintain about the same stoichiometric proportions. The alumina forms about 1% to 8%, by weight, of the welding composition, and preferably about 4% to 6%. In order to cause the energy to be distributed over a larger area we add, in various minor proportions, say 6%, a material capable of reducing the energy concentration and thereby widening the weld. A preferred material for this purpose is a halide salt such as calcium fluoride.

The basic constituent preferably consists chiefly of lime and magnesia in approximately the proportions of three parts of CaO to one part of MgO, by weight; but other proportions are useful and within the invention. Basic materials other than lime or magnesia, for example oxides of manganese, titanium, or the alkali metals, and known fluxing agents such as borax or boric acid, may be added in moderate amounts without greatly changing the essential characteristics of the welding composition, but it is important that the composition be substantially free from iron oxides uncombined with other ingredients of the composition (by being prefused with such ingredients, for instance), and from materials (such as carbonates or moisture) which evolve detrimental amounts of gas or vapor at welding temperatures.

It is possible, and may at times be desirable, to include in the welding composition materials which are transferred to the weld filler material during the welding operation and appear in and modify the properties of the completed weld, for example: ferromanganese, ferrosilicon, ferrochromium, calcium molybdate, carbon, or reducible chemical compounds thereof.

In a specific instance, we fused together 50 pounds of calcium carbonate, 9.4 pounds of magnesium oxide, and 40.5 pounds of silica until the reaction was complete. The materials used were of the purest quality used in the ceramic industries, but the fused product showed the presence, on analysis, of about 5% alumina. The fused material was cooled and granulated, and to each pound, one ounce of fluorspar was added. The material was then ready for use to form the conductive melt which is the principal feature of our process.

Welding compositions which have been used successfully and which serve as representative examples within the invention have the following analyses, by weight:

	I	II	III	IV
Percent CaO	29.5	31.24	29.18	40.12
Percent MgO	8.7	11.01	8.26	0.89
Percent SiO_2	56.4	52.40	57.48	52.94
Percent Al_2O_3	5.4	4.11	4.56	5.80
Percent Fe_2O_3	Low	0.13	0.24	0.23

Before use about 1 part of calcium fluoride was added to 16 parts, by weight, of each of the above compositions.

The chemical condition of the welding composition or medium is important: the acidic and basic constituents should be reacted, the composition should be substantially anhydrous and free from gases, and all reactions which would evolve deleterious amounts of gases during welding should be substantially completed, before the medium is used in the welding process. These conditions are suitably attained by prefusing a mixture of the constituents, preferably in an electric furnace. Certain relatively volatile but chemically stable constituents such as calcium fluoride may be added to the medium either before or after the other ingredients have been fused and cooled. The carbonates of calcium or magnesium may be substituted for the oxides, of course, if the ingredients are prefused.

The physical condition of the welding composition is likewise of the utmost importance. If the molten medium is rapidly solidified by cooling, before grinding and use, more homogeneous and solid welds may be produced than when it slowly loses heat and solidifies. The fused composition is preferably cast as a relatively thin layer against efficient cooling or chilling means such as a cold heavy plate or block of metal, or a water-cooled chill plate, rather than as a large ingot. It is preferred that the rate of cooling be such that substantially all of the solidified welding composition is characterized by a vitreous fracture.

In practicing our process the plates to be welded are arranged as for metal open arc welding. The edges are preferably beveled, but this is less necessary than with arc welding because the "penetration" and width of the weld (the extent to which the edges of the plates are fused during the welding) is dictated by the composition of the flux and the voltage and current employed, and can be closely controlled in our process. Means for "backing-up" the seam during welding is preferably used.

When a weld is to be made between beveled edges the operation is started by filling the groove, space, or gap between the edges of the objects with the welding composition, preferably in powdered or granular form, and a substantial additional quantity of the composition is heaped up along the groove, thereby overfilling the said groove. After the weld is completed, that portion of the composition which has not been fused may be removed, by a vacuum system for example, collected and reused. The portion which has been fused may be lifted from the weld, exposing a clean and uniform weld surface. The fused material may be reground and reused, any volatile constituents, such as halides, being replaced. However, under some circumstances the reuse of the welding composition results in a somewhat inferior weld, probably because the composition has picked up impurities during its use.

According to the welding method of the invention, the end of the welding electrode, which is preferably a bare metal electrode, is first inserted into the welding composition. Since the composition is nonconductive when cold, a conductive path for the welding current is provided by bridging the gap between the electrode and the work with, for example, a sliver of graphite or a wad of steel wool. The power is then applied, the welding composition is locally heated until it fuses and becomes conductive, forming a subsurface pool, and immediately thereafter the end of the electrode begins to fuse and the molten metal begins to deposit in the groove, displacing the subsurface pool of fused welding composition. At the same time the edges of the objects being welded begin to fuse and to coalesce with the deposited metal. The electrode is then fed toward the work and moved along the seam at an appropriate rate, preferably by a mechanical device which may be similar to those which are extensively used in open arc welding, and the welding proceeds without interruption.

The welding proceeds under a protective layer of the composition unobtrusively. There is practically no puffing or visible displacement of the welding medium, no visible sparking, and, indeed, scarcely any external evidence that a weld is being made. The weld is ordinarily completed in one pass, even in thick plate. The welding composition in front of the electrode remains unfused, while the fused composition rises to the top of the completed portion of the weld and solidifies. Even this effect is scarcely visible because of the use of an excess of the welding composition which remains unfused and covers the fused composition and metal.

It is possible in our process to use either alternating or direct current, or direct current superimposed on alternating current. Alternating current alone is preferred.

The results attained are influenced, as in open arc welding, by the potential or voltage difference between the electrode and the work, by the magnitude of the welding current, by the size of the electrode, and by the rates at which the electrode is fed toward the seam and traversed along the seam. Assuming a constant welding speed, the welding voltage and current vary with the plate thickness, each being a function thereof. For example, we may use a welding voltage of about 36 volts and a welding current of about 1500 amperes when welding together steel plates about one inch thick using a bare welding rod about ⅜ inch in diameter and a welding speed along the seam of about 8 inches per minute. The welding current may rise to 2000 amperes or more, and with such heavy currents plates 1.5 to 2 inches thick may be welded in one pass at a rate of 6 or 7 inches per minute.

The preferred welding current is a function of several factors including the diameter of the electrode, the rates of penetration, deposition of metal, and travel along the seam, the penetration of the work piece, and the composition of the flux. It is a characteristic of the invention that, for an electrode of a given size, the preferred current is far greater than can be used successfully in processes heretofore known. The following table indicates the order of magnitude of the current in the old and new processes, for the purposes of comparison, but it will be realized that the invention is not limited to the use of the current values shown.

Electrode diameter inches	Current amperes	
	The invention	Old methods
1/16	500 to 800	170 to 210
1/4	800 to 1200	225 to 300
5/16	1250 to 1700	300 to 400
3/8	1500 to 2200	375 to 525

In welding very heavy plate it is sometimes advantageous to use two passes rather than only

one, because of mechanical difficulties in supplying large amounts of filler metal rapidly. The facts that the weld has little or no internal stress, and that the flux lifts off easily, leaving a clean surface, expedite the two-pass method.

Welds made by our process have certain distinguishing characteristics. A cross section of our weld shows, in most cases, that the planes defining the ultimate zone of fusion at the sides of the weld are approximately parallel. This relation is almost independent of the character of the V and obtains whether the parts are preliminarily beveled to a wide V, to a narrow V, or are not beveled at all. The deposit of metal occurs, not directly under the electrode, but back of it, and there appear to be liquid currents (possibly caused by the so-called "pinch effect") which cause the surface of the resistive composition to be depressed at the point where it is first fused, that is, just behind the electrode, and cause both the deposited metal and the conductive melt to be heaped up back of the electrode. This facilitates the production of a weld having the desirable upwardly convex surface, with some excess metal above the seam, which can either be machined off, or, as in the usual practice, left for reinforcement. The relatively high current densities which are preferably used superheat the molten metal and welding composition, making them highly fluid. The liquid currents set up in this highly fluid mass effectively mix the metal and welding composition, thereby cleansing or washing impurities out of the metal, and then completely separate the metal as it is deposited. As a result, unusually clean and strong metal is deposited. Since the amount of metal solidifying is uniformly wide, unequal stresses, which would tend to warp the plate, are not created, and the weld is of such low internal stress that no evidence of plate deflection is apparent after its completion.

Several circumstances show clearly that our process does not depend on the formation of an arc of the usual type. If, while a weld is being made, the circuit is opened externally of the weld and then closed again while the resistive composition is still molten, the current will immediately resume its flow without any necessity for moving the electrode into contact with the seam as it would be necessary to do to reestablish an arc of the usual type. The heat for melting the electrode is evidently developed in the conductive melt itself.

The conductive welding composition used in our process doubtless performs the protective functions of a flux, but it is much more than a flux, and many compositions which are satisfactory fluxes for arc welding are unsuitable for our purpose. When an electric current is passed through a material which becomes a Nernst conductor at a low temperature a relatively large area of the material will be engaged in the conduction. Common salt (NaCl) is a material of this class: if it is used, the current is conducted from the electrode to the plate almost entirely by the fused electrolyte. So much salt is involved in the conduction that the energy density is insufficient to produce fusion of the plate or wire. If, on the other hand, a material becomes a Nernst conductor at an exceedingly high temperature, very little of the material is involved in the conduction, the energy is thereby so concentrated as to melt very deeply and with very small cross section. By a proper selection of welding composition, as explained hereinabove, the energy density on the parts to be welded may be satisfactorily controlled and the production of a sound weld may be assured.

This application is a continuation, in part, of our prior applications Serial Numbers 657,836 and 705,892, respectively, filed February 21, 1933 and January 9, 1934.

We claim:

1. The process of electric welding which comprises the steps of juxtaposing an electrode and a conductive member on which metal is to be deposited; establishing between said member and said electrode a conductive path of a high-resistance melt of chemically stable fusible material having at welding temperatures substantially the fluidity and electrical conductivity of a fusible silicate, and substantially free from substances capable of evolving large amounts of gases during welding; passing through said melt an electric current of sufficient strength to maintain its conductivity, progressively melt the required amount of metal, and cause the resulting molten metal to coalesce with said member; and maintaining said melt in contact with said electrode throughout the welding operation to avoid the formation of a substantial air-conducted electric arc between the electrode and the said conductive member.

2. The method of electric welding by melting a metal electrode, depositing the metal so melted upon a metal work piece, and coalescing said melted metal with adjacent fused metal of said work piece, which method comprises supplying heat for said welding by passing an electric current, at a density of upwards of about 2000 amperes per inch of diameter of said electrode, substantially wholly through a pool of silicate fused in situ, without the formation of any substantial gas-conducted electric arc.

3. The method of electric welding by melting a metal electrode, depositing the metal so melted upon a metal work piece, and coalescing said melted metal with adjacent fused metal of said work piece, which method comprises supplying heat for said welding by passing an electric current from said electrode to said work piece through a fused nonmetallic material which acts as a high-resistance conductor at welding temperatures and which does not evolve substantial amounts of gas when in contact with the melted weld metal, and maintaining said material in constant contact with said electrode and work piece to avoid the formation of a substantial air-conducted electric arc between the electrode and work piece.

4. The method of electric welding by melting a metal electrode, depositing the metal so melted upon a metal work piece, and coalescing said melted metal with adjacent fused metal of said work piece, which method comprises supplying heat for said welding by passing an electric current from said electrode to said work piece through a pool of nonmetallic material fused in situ without material evolution of gas, and maintaining said pool in constant electrical contact with said electrode and work piece to avoid the formation of a substantial air-conducted electric arc between the electrode and work piece; said non-metallic material being one which acts as a high-resistance conductor at welding temperatures.

5. The process of electric welding which comprises the steps of juxtaposing a metal electrode and a conductive member on which metal is to

be deposited; establishing between said member and said electrode a conductive path of a high-resistance melt of fusible silicate, substantially free from substances, such as uncombined iron oxide, capable of evolving large amounts of gases when fused in contact with the metal to be deposited; passing through said melt an electric current of sufficient magnitude to maintain the conductivity, progressively melt the said electrode and cause the resulting molten metal to coalesce with said member; and maintaining said melt in contact with said electrode and member throughout the welding operation.

6. The process of electric welding which comprises the steps of juxtaposing a metal electrode and a conductive member on which metal is to be deposited; establishing between said member and said electrode a conductive melt comprising an alkaline earth metal silicate, alumina and an alkaline earth metal fluoride, substantially free from substances, such as uncombined iron oxide, capable of evolving gases when fused in contact with the metal to be welded; passing through said melt an electric current of sufficient magnitude to maintain the conductivity, progressively melt the said electrode and cause the resulting molten metal to coalesce with said member; and maintaining said melt in contact with said electrode and member throughout the welding operation.

7. The process of electric welding which comprises juxtaposing a metal electrode and a metal member on which metal is to be deposited from said electrode; filling the gap between said electrode and said member with a finely-divided, unbonded, nonmetallic material which is fusible at welding temperatures; heaping an additional amount of said material above said gap so as to submerge said electrode for a substantial distance; fusing a portion of said material in said gap to render the material electrically conductive; progressively moving said electrode along said member; passing through the circuit comprising said electrode, fused material, and work piece an electric current sufficient to melt successive portions of said electrode and said metal member and to maintain a pool of said nonmetallic material in contact with said electrode and adjacent to and covering the molten metal; and simultaneously maintaining said fused pool, said end of said electrode, and said molten metal submerged under a quiet layer of said nonmetallic material.

8. The method of uniting metal work pieces by fusion depositing added metal from an electrode and coalescing such added metal with adjacent fused metal of the work which comprises juxtaposing the work pieces to be united so that a space is provided therebetween at the line of intended union, overfilling said space with unbonded particles of a prefused solidified and ground material capable of refusion in situ and active when fused to cleanse the fused depositing metal of an electrode, such refusion and cleaning occurring without substantial apparent gas evolution, and traversing said space with the end of an electrode of the metal to be deposited, said end being submerged in said material, while passing current between the work and the electrode of a magnitude to maintain a localized subsurface pool of said material fused and to fuse the electrode at a rate to effect deposit of sufficient metal therefrom to displace said pool and substantially fill said space as traversed, and maintaining a substantially quiet surface layer of said unbonded particles over the area of fusion.

9. The method of uniting metal work pieces by fusion depositing added metal from an electrode and coalesing such added metal with adjacent fused metal of the work, which comprises juxtaposing the work pieces to be united so that a space is provided therebetween at the line of intended union, traversing said space with an electrode of the metal to be deposited while passing an electric current between the work and the electrode of a magnitude to fuse the latter at a rate to effect deposit of sufficient metal therefrom to substantially fill said space as traversed, bridging the fusing end of said electrode and the adjacent fused local area of the work with a pool of material fused in situ without substantial gas evolution, said fused material being electrically conductive and active to cleanse the fused metal of the electrode and the work, and simultaneously maintaining said fused pool, said end of said electrode and said local area of the work submerged under a quiet protective layer of unbonded particles.

10. A process of electric welding which comprises the steps of juxtaposing a metal electrode and a conductive object on which metal is to be deposited, placing between said object and said electrode a high resistance conductive path consisting of a prefused welding composition, and passing through said electrode, welding composition, and object an electric current of sufficient magnitude to establish and to maintain the conductivity of said composition, to melt successive portions of said electrode, and to cause the resulting molten metal to coalesce with said object; said welding composition being substantially free from uncombined iron oxide and from materials which evolve gas at welding temperatures and having for its principal ingredients silica, lime, magnesia, and alumina, and also containing a minor proportion of a halide salt, the silica, lime and magnesia being in approximately the proportions of 27 to 38 parts lime, 9 to 16 parts magnesia, and 60 parts silica, and the alumina being about 4% to 6% of the composition.

11. A process of electric welding which comprises the step of forming a conductive high-resistance melt, containing a major proportion of alkaline earth metal silicate and substantially free from uncombined iron oxide, on a metal part to be fused; and passing an electric current through a circuit comprising said melt and said metal part.

12. A process of electric welding which comprises the steps of juxtaposing a metal electrode and a conductive member on which metal is to be deposited; establishing between and in contact with said member and said electrode a conductive melt of fusible silicate, substantially free from substances capable of evolving gases when fused in contact with the metal to be deposited; and passing through said melt an electric current of sufficient magnitude to maintain the conductivity, progressively melt the said electrode and cause the resulting molten metal to coalesce with said member.

13. A process of electric welding which comprises the steps of juxtaposing a metal electrode and a conductive member on which metal is to be deposited; establishing between and in contact with said member and said electrode a conductive path of high-resistance melt contain-

ing a major proportion of alkaline earth metal silicate and substantially free from uncombined iron oxide; and passing along said conductive path an electric current of sufficient magnitude to maintain the conductivity, progressively melt the said electrode and cause the resulting molten metal to coalesce with said member.

14. A process of electric welding which comprises the steps of juxtaposing a metal electrode and a conductive member on which metal is to be deposited; establishing between and in contact with said member and said electrode a conductive melt comprising an alkaline earth metal silicate and an alkaline earth metal fluoride; and passing through said melt an electric current of sufficient magnitude to maintain the conductivity, progressively melt the said electrode and cause the resulting molten metal to coalesce with said member.

15. A process of electric welding which comprises the steps of juxtaposing a metal electrode and a conductive member on which metal is to be deposited; establishing between and in contact with said member and said electrode a conductive melt containing a major proportion of alkaline earth metal silicate and substantially free from uncombined iron oxide; passing electric current through said melt to maintain the conductivity and progressively melt said electrode; and moving said electrode along said member while maintaining the current and the conductive melt therebetween.

16. A process of electric welding which comprises the steps of juxtaposing a metal electrode and a conductive member on which metal is to be deposited; establishing between and in contact with said member and said electrode a conductive melt of fusible silicate substantially free from uncombined iron oxide; and passing through said melt an electric current of sufficient magnitude to maintain the conductivity, progressively melt the said electrode and cause the resulting molten metal to coalesce with said member.

17. A process of electric welding which comprises the steps of juxtaposing a metal electrode and a conductive member on which metal is to be deposited; establishing between and in contact with said member and said electrode a conductive melt of an alkaline earth metal silicate substantially free from uncombined iron oxide; and passing through said melt an electric current of sufficient magnitude to maintain the conductivity, progressively melt the said electrode and cause the resulting molten metal to coalesce with said member.

18. A composition for electric welding containing a major proportion of alkaline earth metal silicate, and being substantially free from uncombined iron oxide and from substances capable of evolving gases under welding conditions.

19. A composition for electric welding containing a major proportion of calcium silicate, and being substantially free from uncombined iron oxide and from substances capable of evolving gases under welding conditions.

20. A composition for electric welding containing a fluoride and a major proportion of alkaline earth metal silicate, and being substantially free from uncombined iron oxide and from substances capable of evolving gases under welding conditions.

21. A composition for electric welding containing a fluoride and a major proportion of calcium silicate and being substantially free from uncombined iron oxide and from substances capable of evolving gases under welding conditions.

22. A finely-divided unbonded fusible electric welding composition containing a fluoride and a major proportion of an alkaline earth metal silicate.

23. A finely-divided unbonded fusible composition for use in electric welding employing a bare metal electrode as a source of weld metal, said composition being substantially free from substances capable of evolving a detrimental quantity of gas under welding conditions and containing calcium fluoride and a major proportion of one or more alkaline earth metal silicates.

24. A fluxing material for electric welding comprising metallic silicate and calcium fluoride.

25. A composition for electric welding comprising fluorspar, magnesium silicate, and calcium silicate, the latter silicate being present in predominant proportion.

26. An electric welding composition which is conductive when molten, consists chiefly of silicates, and contains about 1% to 8% alumina.

27. A prefused electric welding composition which is conductive when molten and the principal constituents of which are alkaline earth metal silicates, said composition containing about 1% to 8% alumina and being substantially free from materials such as uncombined iron oxide which evolve large volumes of gas or vapor at welding temperatures.

28. A prefused electric welding composition which is conductive when molten, is substantially free from uncombined iron oxide and from materials which evolve large amounts of gas at welding temperatures, and the principal ingredients of which are silica, alumina, and at least one basic ingredient of the group consisting of lime and magnesia, the basic ingredients being present in an amount between about 70% and about 100% of that theoretically required to combine with all of the silica present to form metasilicates, and the alumina being about 2% to 8% of the composition; and said composition having as a minor ingredient an alkaline earth metal fluoride.

29. A prefused and comminuted electric welding composition which has a vitreous fracture, is conductive when molten, and consists substantially of silica, lime, magnesia, alumina, and calcium fluoride, the silica, lime, and magnesia being in approximately the proportions of 27 to 38 parts lime, 9 to 16 parts magnesia, and 60 parts silica, the alumina being about 4% to 6% and the calcium fluoride being about 5% of the composition; said composition being substantially free from uncombined iron oxide and from materials which evolve gas or vapor at welding temperatures.

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DEFENDANTS' EXHIBIT NO. 101.

June 15, 1926. 1,589,017

J. C. LINCOLN

METHOD AND MEANS FOR ELECTRIC ARC WELDING

Filed Oct. 11, 1918 2 Sheets-Sheet 1

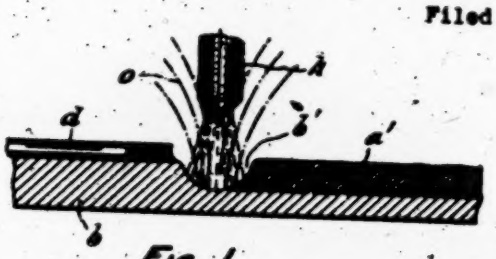

FIG. 1.

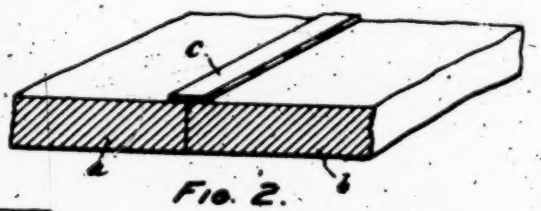

FIG. 2.

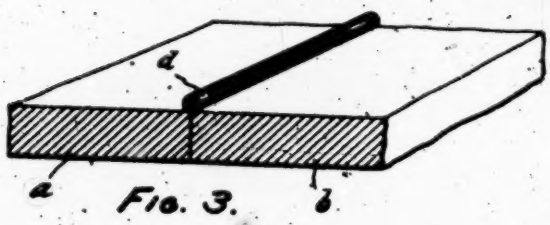

FIG. 3.

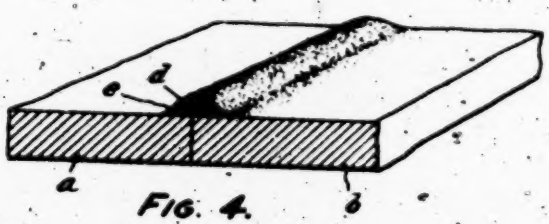

FIG. 4.

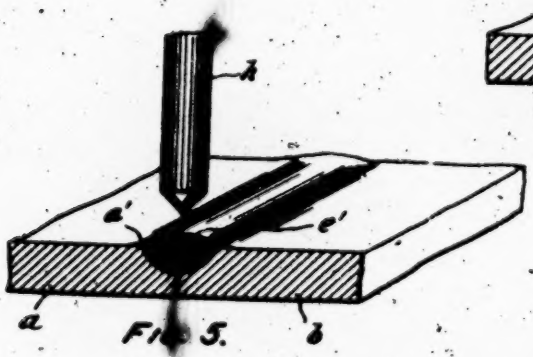

FIG. 5.

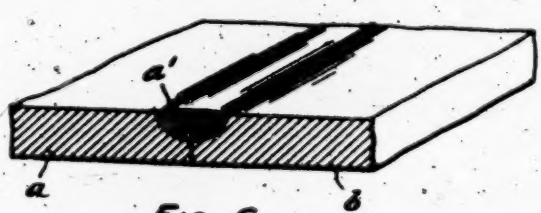

FIG. 6.

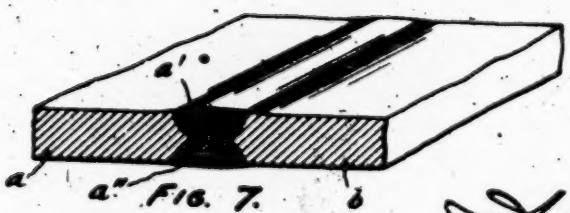

FIG. 7.

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METHOD AND MEANS FOR ELECTRIC ARC WELDING

Filed Oct. 11, 1918 2 Sheets-Sheet 2

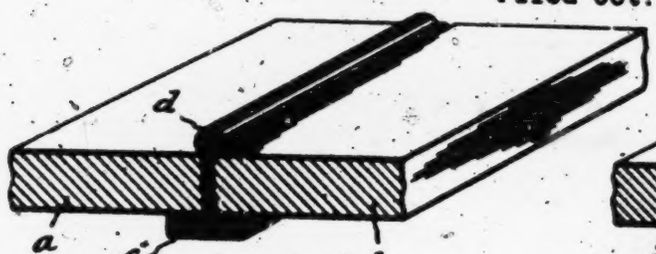

FIG. 8.

FIG. 9.

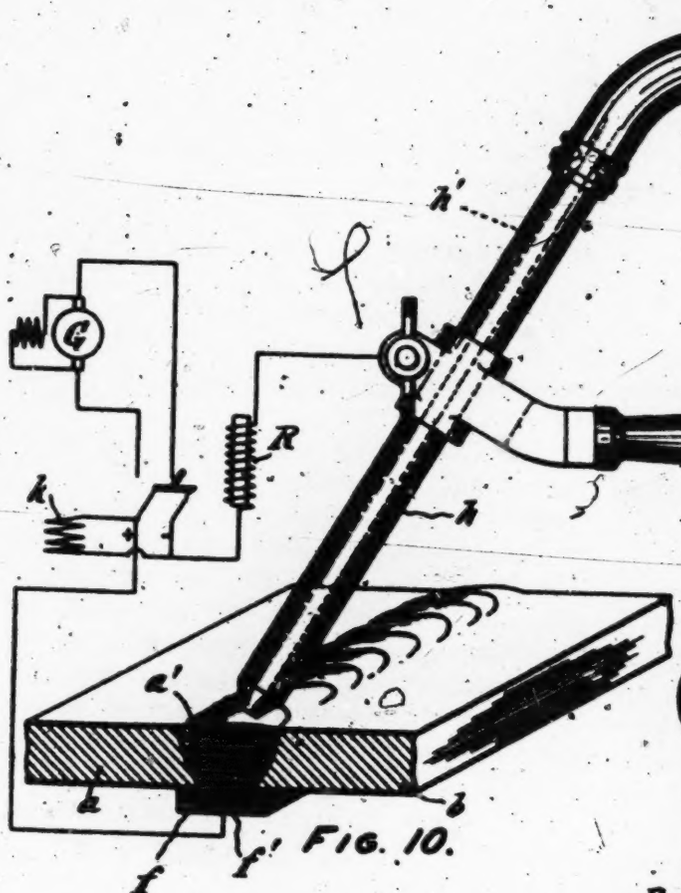

FIG. 10.

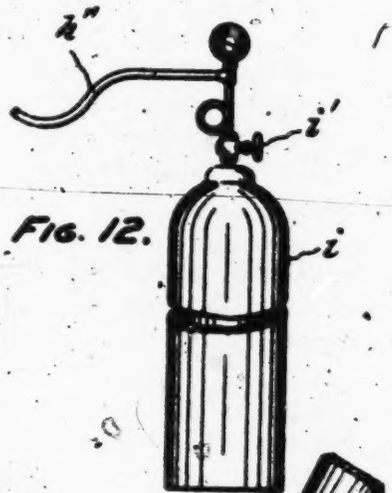

FIG. 12.

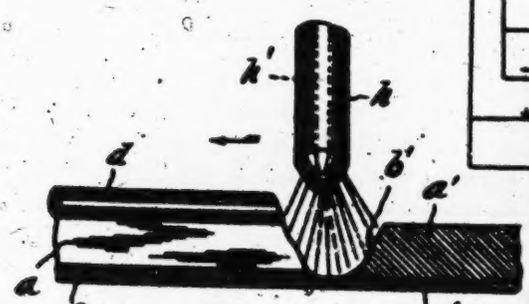

FIG. 13.

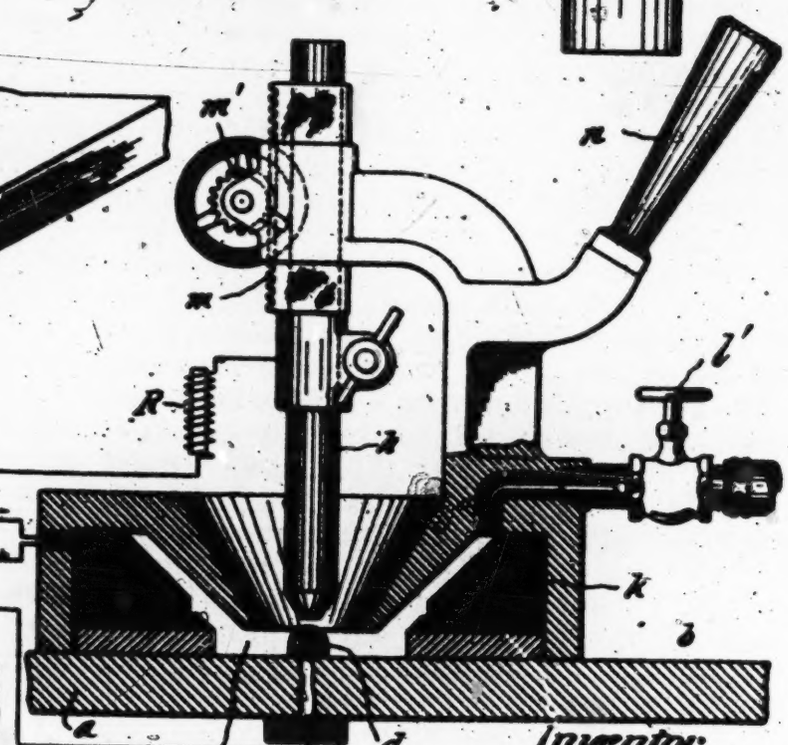

FIG. 11.

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Patented June 15, 1926. 1,589,017

UNITED STATES PATENT OFFICE.

JOHN C. LINCOLN, OF EAST CLEVELAND, OHIO.

METHOD AND MEANS FOR ELECTRIC-ARC WELDING.

Application filed October 11, 1918. Serial No. 257,784.

My invention relates to improvements in methods of welding, and has for its object the production of welds which will be ductile, as strong or stronger than the metal welded, economical in the cost of labor and current, and which preferably avoids the preparation of the materials welded.

Incidentally, my object further contemplates the control of the electric arc by which the welding is accomplished, so that it may be most efficiently directed to the successive points at which the welding operation takes place, and steadied for the production of a strong, ductile and even weld.

It is well known that fairly satisfactory welds can be made upon steel plates by means of the oxy-acetylene flame or the electric arc. The principal objection to the work hitherto produced by either of these means is that the welds are lacking in ductility, while another objection is found in that said welds are not as strong as the metal united.

However, an important item, both as to expense and delay has existed in the necessity for preparing the metal for welding. This preparation of sheet metal ordinarily has consisted in beveling the edges of the sheets of metal to be welded, so that the opposing or substantially abutting surfaces would exhibit an angle approximately of 90°, in order to enable the operative to reach with the arc, the bottom of the space thus afforded for the weld. Accordingly, I have devised a method for welding sheet metal, without any previous preparation of the edges.

During my experiments I have ascertained that in order to obtain ductility in a weld, it is necessary to avoid as far as possible, the oxidizing action of the air, and this I have accomplished by using both an inert gas about the arc, and a protective medium for the weld, which I may term a slag.

The inert gas, such as nitrogen or carbon dioxide, for example, may be supplied to the arc in any suitable manner, as by the use of a hollow carbon through which the gas is constantly supplied during the welding operation, or by means of a separate gas-supplying element positioned adjacent to the arc. The gas supply is such that the atmosphere is excluded from the highly heated metal beneath the arc and oxidation thus is avoided.

In connection with said inert gas, moreover, I may employ a slag covering for the welded seam, or this may be used independently for the purpose of excluding the air from the welded seam during its production. The material forming such slag is melted by the excessive heat of the arc, floats on top of the molten metal and serves as a protection therefor, which in conjunction with the inert gas, serves as an additional protection against oxidation and the result is a weld of such improved quality as to be sufficiently ductile for all practical purposes.

By employing the method or methods above outlined, riveting may be avoided, and much of the work upon steel bridges, steel hulls for vessels, boilers, and the like may be performed with material gain of time and at a very much lower cost than is possible with riveting. In addition, the weld may be made much stronger than the original metal welded, while the riveted joint has a strength at best from 65% to 85% of that of the members thus united.

The welding operation may be conducted with the plates of sheets of metal in substantial abutment in edgewise relation, or said plates of sheet steel may be slightly spaced apart or separated, in which case a bridging strip of sheet steel is positioned beneath the separated edges, subsequently to be welded into the seam thus formed for strengthening and reinforcing it. In either event, it is desirable to supply additional metal, which may be of any suitable alloy, such as nickel steel or manganese steel, for example, to replace certain losses of metal, and to fill the space between the edges of the plates.

In my application for patent, filed September 19th, 1918, Ser. No. 254,773, I have described and claimed more generically, the process herein outlined and particularly the welding of the plates first on one side for slightly more than one-half their thickness and then upon the opposite side to form an intersecting continuous weld. The present application describes the foregoing in connection with certain improvements, and specifically claims in addition, the method of welding with a bridging strip of metal as above set forth.

In welding sheet metal plates in spaced relation, it is essential that the electric arc shall reach the bottom of the space thus formed and fuse into the welded seam, the metal of the bridging strip along the abutting surface thereof. Accordingly, it is very

desirable that the arc shall be stabilized and that the inert gas shall be supplied thereto and to the molten metal within said space, for the purpose of producing welds or seams of the necessary ductility. It will be apparent that with the welding conditions indicated, the inert gas should be introduced immediately adjacent to the arc, and this I have accomplished in the simplest manner possible by supplying such gaseous medium through a hollow carbon or electrode. Moreover, if desired, a suitable powdered flux may be introduced with the inert gas supply, although this need not generally be resorted to.

To insure the stabilizing and directing magnetic field for the arc, I may also provide an adjacent solenoid winding mounted to travel with the arc and maintain it within concentric lines of magnetism. It is known that an electric arc in the presence of a magnetic field, tends to be deflected laterally, and the deflection occurs in the direction across magnetic lines of such field. However, by producing the field of force with its magnetic lines parallel to the direction assumed by the electric arc, such field will exert no appreciable deflecting force. This being the case, it is clear that the magnetic lines passing from the material to be welded back into the exciting magnet, will tend to blow out any component of the arc not in line with the common axis of the electrode and magnetic field. It also will tend to make the arc itself more nearly a cylinder than a cone, as is normally the case. With this directive, stabilizing action of the magnetic field, however, there is coupled the liability of blowing out the arc, and preferably the arc-forming circuit is so equipped as to offset this.

Connected in series circuit with the arc, is a suitable inductive resistance so designed that the amount of the ohmic resistance shall be such as to give an arc of approximately thirty-five to forty volts, the amount of self-induction being sufficient to avoid frequent breaking of the arc. It is clear that with the use of inductive resistance, energy will be stored up in the inductance during the instant that the current is increasing from zero to normal, and this energy will be released at the arc in the guise of a momentary increase in voltage before the circuit can be broken. It is possible to design this inductive resistance so that any desired momentary increase of voltage is provided at the arc, necessary to make it substantially stable. For example, with a voltage of fifty-five volts in the external circuit and approximately forty volts across the arc, the loss in the solenoid winding or ohmic portion of the inductive resistance would be fifteen volts. By proper design of the inductive resistance, in a manner well known to those skilled in the art, the welding arc may be made as stable as it would be with a current of from one hundred to one hundred fifty volts provided across a non-inductive resistance.

The method or methods of my invention as herein claimed are accomplished by the negative electrode of an electric arc in conjunction with either or any of the features contributing to the formation of an efficient fabricated seam between plates of steel or other metals or alloys thereof, and by any suitable means. Accordingly, my invention is not limited in its practice to the apparatus which I shall hereinafter describe, nor to the exact details recited in explaining the preferred methods employed. These may best be set forth in connection with the accompanying drawings wherein:—

Fig. 1 is a view partially diagrammatic in character, and in cross-section whereby I have indicated the method of arc-welding in its simplest form.

Fig. 2 and Fig. 3 are fragmentary views showing sections of sheet metal plates positioned for seam-welding.

Fig. 4 is a view similar to Fig. 3 illustrating the covering with an inert body of flux.

Fig. 5 shows the seam as formed with the covering of flux in Fig. 4.

Fig. 6 and Fig. 7 respectively show the initial and secondary welded seams to form intersecting bodies of alloyed metal.

Fig. 8 illustrates the method of seam-welding with the use of a bridging strip and an alloy.

Fig. 9 is a similar view introducing the additional metal in part by the use of an interposed shim.

Fig. 10 is a view partially diagrammatic in character, showing apparatus for effecting the weld with a gaseous inert medium.

Fig. 11 is a similar view illustrating somewhat more elaborate apparatus for producing the magnetic stabilizing field and supplying the inert medium to the arc.

Fig. 12 is a view upon a much smaller scale, partially broken away, illustrating a tank for the compressed gas, and

Fig. 13 is another view partially diagrammatic in character and partially in cross-section illustrating the preferred method of forming the welded seam by means of the hollow electrode.

The same character of reference is employed throughout the several figures of the drawings, to indicate similar parts.

As indicated respectively in Figs. 1 and 13, the welding operation may initially embrace either a portion of, or the entire thickness of the sheets to be welded, although the latter contemplates complete welding at a single operation, and consequently may be accomplished more rapidly than when the

intersecting welds must be formed from opposite faces of the metal.

The sheets *a b* are positioned with their edges substantially in abutment, as shown in Figs. 2 to 6. A strip *c* or wire *d* of steel or alloy, such as nickel-steel or chromium-steel, for example is placed adjacent to the abutting edges, and the flux *e* is supplied to cover the parts, as in Fig. 4. I may use asbestos, sodium-carbonate, borax or other suitable materials for the flux; the requisite thereof being that it will persist beneath the electric arc in sufficient volume to cover and exclude the air from the molten metal.

In Figs. 8 and 9, the sheets or plates *a, b* are shown slightly separated, with the additional wire *d* positioned above the interspace and a bridging strip *f* disposed beneath the same. A shim *g* may also be interposed, if desired, for supplying additional metal to the welded seam.

The welding is assumed to be accomplished by the negative electrode *h* which is caused to travel from right to left in Figs. 1 and 13, or away from the observer in Figs. 10 and 11, along the opposing edges of the sheets to be seam welded.

There is shown in Fig. 10 a hollow carbon electrode *h* having a longitudinal passage *h'*, shown in dotted lines, communicating with the flexible tube *h''*, through which a suitable inert gas may be supplied to the arc, as from a pressure-tank *i*. This may be asumed to be charged with nitrogen or carbon-dioxide, for example. The handle h^2 is used by the operative for directing the travel of the arc, which may be observed through a dark glass or welding helmet for shielding the eyes.

Given a sufficient supply of gas, controllable at a suitable valve, such as *i'*, it will be understood that the arc and molten metal constantly are maintained in an inert envelope or atmosphere, which emanates from the active portion of the arc and thus will protect the molten steel or other metal from any oxidizing effect tending to impair the ductility of the welded seam.

The apparatus shown in Fig. 11 is somewhat more elaborate, in that it provides a solenoid *k* surrounding the electrode, in addition to the peripheral passage *l* connected with the gas supply valve *l'*, through which the inert gas supply may be directed adjacent to the exterior of the arc. If desired, a pulverulent flux may also be carried to the molten metal by the gas current.

The electrode is shown equipped with a rack and pinion adjustment *m m'* and the entire device is moved by handle *n*, as the welding operation progresses.

The diagrammatic portions of Figs. 10 and 11 illustrate the generator G which is shown connected through the inductive resistance R with the welding electrode *h* and also with the solenoid windings *k*, provided for stabilizing the arc.

Preferably, the plates *a, b* need not be specially prepared for welding, but are disposed with their edges in abutment, or in opposition to each other. The arc is then struck, its action is carefully observed and the electrode, which may either be of carbon or metal, is progressively advanced along the seam as rapidly as the welding is accomplished. A weld either slightly in excess of one-half the thickness of the plates or sheets *a'*, as in Figs. 1, 5 and 6, may thus be perfected, or it may proceed the entire thickness thereof, with the use of the backing or bridging strip, as in Figs. 10 and 13; in the latter case the strip becomes a part of the welded seam, since the arc reaches and fuses its exposed section. To complete the weld of Figs. 5 and 6, the arc is progressively applied to the opposite sides of the sheets to produce an intersecting weld *a''* shown in Fig. 7. Any losses of metal or added metal will be supplied by the wire or strip of steel or alloy which will contribute to the body and characteristics of the welded seam thus produced.

In Fig. 1 I have endeavored somewhat diagrammatically to show the action of the welding arc in forming the partial seam of Fig. 6 in accordance with my invention. The electrode *h* is pictured as drawn from the steel *b*, and in the process of welding, there results a marked depression *b'*, which presumably is due to the boiling out of the molten metal under the heat of the electric arc. The progress of the arc is assumed to be from right to left and the metal is melted from the left side of the depression and from the wire *d* under the intense action of the arc, and actually transferred to the right side thereof, where it solidifies. A somewhat violent agitation of the molten metal takes place beneath the arc, so that with the addition of any alloying material, a fairly uniform ductile seam results.

I have endeavored to indicate by the dotted lines *o* in Fig. 1, the magnetic lines of force wherein the arc is concentrically enclosed during the excitation of the windings *k*. These serve to converge somewhat or render more truly cylindrical, the normally frusto-conical shape of the arc, and by their concentric directive effect, materially stabilize the welding action of the electric arc, while the continuity of such arc is contributed to by the inductance R; all as previously explained.

It should be understood that the arc-welding described is fabricated beneath a suitable inert medium, either solid or gaseous or both in conjunction. Thus in Fig. 4, the flux *e* is shown in position for arc-welding, while in Fig. 5, the partial seam weld *a'* has been formed by the electrode *h* and a crust

e' still remains from the excess of fluxing inert material employed.

The gaseous inert medium, of course, is supplied to the arc, either interiorly or exteriorly thereof, during the fabrication of the seam, and in sufficient volume to exclude the air from the molten metal and insure a ductile weld. The gas is better adapted to penetrating the interspaces between the sheets, as in Figs. 8, 9 and 11 for the purpose of protecting the molten steel, and a weld *f'* as shown in Fig. 10, extending into the body of the bridging strip *f* and incorporating the additional or alloying material, may be fabricated completely during the passage of the electric arc, while fully protected by the inert gaseous medium. Thus, the seam-welding may proceed more rapidly than with the method described in my prior application and shown in Figs. 5, 6 and 7. However, both methods for fabricating seam-welds, repairs or the like, have their advantages. Thus the latter method, although requiring two operations, produces intersecting welds normally of greater thickness than does the method herein specifically claimed.

Fig. 13 illustrates the procedure for welding with a backing or bridging strip completely through the thickness of the sheets, employing therefor a hollow carbon directing its inert medium within the depression *b'*, centrally of the arc. The arc is shown of somewhat greater spread than that of Fig. 1, for the reason that the stabilizing magnetic field is assumed to be absent. It is also apparent that a larger body of metal or wire *d* is required for filling the interspace between the plates or sheets of steel, as shown in Figs. 8, 9 and 11.

These welding operations take place under ideal conditions for producing a ductile weld, by maintaining the molten metal within or beneath a protecting inert covering, either gaseous or solid, or both combined. Ordinarily, however, the inert gas is sufficient for protecting the weld from oxidation or other deleterious action, and this medium possesses the advantage of leaving no crust or particles, while being more readily controlled and directed during the welding operations.

Having now described the preferred modes and means for practicing my invention, I claim and desire to secure by Letters Patent, the following:—

1. The method of arc-welding, which consists in surrounding the molten metal with an inert medium during the welding operations, substantially as set forth.

2. The method of arc-welding, which consists in supplying an inert gaseous medium to the arc and the arcing surface of the welded metal interiorly of said arc; substantially as set forth.

3. The method of arc-welding, which consists in advancing the arc sprung from a non-metallic electrode along the metal to be welded and maintaining the molten metal under a slag covering, substantially as set forth.

4. The method of arc-welding, which consists in supplying to the arc and the welded metal a volume of inert gas, sufficient to exclude the air in open arc welding operations, substantially as set forth.

5. The method of arc-welding, which consists in advancing the welding arc and a member supplying an inert gaseous medium concurrently along the seam undergoing the welding operations, substantially as set forth.

6. The method of arc-welding, which consists in applying a slag covering to the seam undergoing the welding operation and directing a supply of an inert gaseous medium as an envelope for the molten metal during the action of the arc, substantially as set forth.

7. The method of arc-welding, which consists in supplying an inert gaseous medium at the apex of the welding arc, substantially as set forth.

8. The method of arc-welding which consists in opposing the unprepared edges of the sheets to be united in spaced relation, supplying a body of welding metal, directing an arc along the opposing edges, and maintaining a supply of inert gas adjacent to the effective portion of the arc, substantially as set forth.

9. The method of arc-welding which consists in opposing the unprepared edges of the sheets to be united in spaced relation, with a bridging strip of metal positioned along one side thereof, supplying a body of welding metal and directing an arc along the opposing edges to produce a seam, substantially as set forth.

10. The method of arc-welding which consists in opposing the unprepared edges of the material to be united in spaced relation, directing an arc along said edges, supplying an inert gaseous medium adjacent to the effective portion of the arc, and melting additional welding metal directly to the opposing edges of the welded material to form a ductile seam therebetween, substantially as set forth.

11. The method of arc-welding which consists in opposing the unprepared edges of the metal, directing an arc along said edges and supplying an inert gas interiorly of the arc during the welding operation, substantially as set forth.

12. The method of arc-welding which consists in opposing the unprepared edges of the material to be united, supplying additional welding material thereto, directing an arc along said edges and material to produce

a welded ductile seam, and meantime maintaining a supply of inert gas interiorly of the arc, substantially as set forth.

13. The method of seam welding with an uncoated non-metallic electrode, which consists of maintaining the molten metal producing the welded seam beneath a slag covering during the welding operation, substantially as set forth.

14. The method of seam welding with an uncoated non-metallic electrode, which consists in supplying a body of metal to the seam to be welded and maintaining the molten metal producing the welded seam beneath a slag covering during the welding operation, substantially as set forth.

15. The method of welding, which consists in enveloping the heating flame in an inert medium and maintaining the molten metal producing the welded seam beneath an inert gas and a slag covering during the welding operation, substantially as set forth.

16. The method of welding, which consists in opposing unprepared edges of the sheets to be united, supplying an independent body of metal thereto, providing a slag covering for said opposing edges, and causing a heating flame to travel along said edges, substantially as set forth.

17. The method of arc-welding which consists in placing the sheets to be welded in opposition, but separated from each other, positioning a metal bridging strip beneath the separated edges of said sheets, directing a welding arc within the space separating said edges and welding them to the bridging strip by advancing the arc as the metal is fused, substantially as set forth.

18. The method of arc-welding which consists in placing sheet steel plates with their edges slightly separated, positioning a bridging strip beneath said edges, directing a traveling electric arc within said space, and supplying additional metal to the seam thus formed, sufficient approximately to fill the space between the welded plates, substantially as set forth.

19. The method of arc-welding which consists in positioning the members to be united with their edges spaced apart, bridging said space by a bottom strip of metal, striking the electric arc within said space, welding the edges and strip into a common seam, maintaining a supply of inert gas at the active portion of the arc, and causing the travel of the arc and gas supply along the edges as the welding operation progresses, substantially as set forth.

20. The method of arc-welding which consists in positioning the members to be welded with their edges spaced apart, bridging said space by a metal strip, striking the electric arc within said space, supplying additional metal to the arc sufficient approximately to fill said space, and causing the travel of the arc along the separated edges, whereby the members, the bridging strip and the added metal are fused into a reinforced seam, substantially as set forth.

21. The method of arc-welding which consists in positioning sheet steel plates in narrowly spaced relation with a bridging strip beneath said space, causing the travel of the electric arc along the edges of said plates, meantime stabilizing said arc by a magnetic field, and supplying to the seam as thus formed, additional metal sufficient approximately to fill the space between said plates, whereby a reinforced seam is formed, substantially as set forth.

22. The method of arc-welding, which consists in disposing the sheets of metal to be united with their edges in opposition directing an electric arc progressively along said edges, and supplying to the seam thus produced a pre-positioned alloying member capable of imparting the desired characteristics to the completed seam, substantially as set forth.

23. The method of arc-welding, which consists in positioning plates of sheet steel with their edges in opposition, directing an electric arc along said edges to produce a fusion between said plates, supplying a pre-positioned alloying member of different tensile strength to the seam thus produced, and protecting the metal while in molten condition by an inert medium, substantially as set forth.

24. The method of uniting sheet steel plates, consisting in placing their edges in opposition, causing the travel of an electric arc along said edges, pre-positioning an alloying member of definite characteristics and size, supplying to the seam in molten form as the same is fabricated, an alloy such as manganese steel sufficient to complete a seam approximating the cross-section of the plates united, and protecting the metal while in molten condition by an inert medium, substantially as set forth.

25. The method of arc welding which consists in disposing the members to be welded in opposition to each other, positioning a welding member for augmenting the seam substantially in the location thereof, covering the same with sodium carbonate, and directing the electric arc along said member and the members to be welded, to produce a seam, substantially as set forth.

26. The method of arc welding which consists in disposing the members in welding position, placing a seam-forming member substantially in the location of the desired seam, covering the same with sodium carbonate, and directing the travel of an electric arc along the location of the seam progressively as the metal and slag are fused, substantially as set forth.

27. The method of arc welding which con-

sists in disposing the members in welding position, placing a supply of sodium carbonate along the line of the proposed seam, and directing an electric arc progressively against said members to effect fusion of the metal and its slag covering substantially as set forth.

28. The method of arc welding which consists in disposing the members to be united in welding position, placing a charge of sodium carbonate along the line of the intended seam and directing an electric arc along the same, meantime supplying to the completed seam progressively, sufficient additional molten metal beneath the slag covering in fusion with the said members, substantially as set forth.

29. Means for forming an arc weld, comprising an electrode, means for supplying an inert gas to its arc, and an energizing electric circuit connected with said electrode, substantially as set forth.

In testimony whereof I do hereto affix my signature.

JOHN C. LINCOLN.

DEFENDANTS' EXHIBIT NO. 145.

Patented Apr. 15, 1930 1,754,566

UNITED STATES PATENT OFFICE

WILBER B. MILLER, OF FLUSHING, NEW YORK, ASSIGNOR TO OXWELD ACETYLENE COMPANY, A CORPORATION OF WEST VIRGINIA

WELDING

No Drawing. Application filed January 27, 1926. Serial No. 84,941.

The invention relates to rods or the like for metal-depositing operations, such as fusion welding. Rods prepared in accordance with the invention may be used in either the arc process or the blowpipe process.

The difficulty most often encountered in fusion welding is in depositing the metal in a clean and homogeneous condition and in securing a firm bond with the metal on which the deposit is made. It is sometimes desirable to add to the metal as it is deposited a constituent not already present, or to increase the content of a constituent already present, but as a general rule it is preferable to produce a rod of such composition that the introduction of elements during the welding operation will be unnecessary. Successful welding then becomes merely a question of depositing the metal in suitable physical condition and of preventing or controlling the loss of constituents therefrom, as by oxidation, while the metal is molten.

According to the present invention, the welding rod or the like is provided with a coating partially or completely enclosing it, the composition of the coating being such that a slag of molten manganese silicate will be formed during the welding or other depositing operation. The addition to the deposited metal of chemical elements present in the coating is not precluded, and in general will occur, at least to a small extent, but the principal purpose of the coating is to produce a slag blanket which will prevent or diminish the loss of chemical elements from the deposited metal, prevent or diminish absorption by the metal of atmospheric and combustion gases, and promote the deposition of the metal in a clean, sound, and homogeneous condition without unduly taxing the skill of the welder.

In addition to the primary object of providing a blanket of molten manganese silicate I may also provide auxiliary slag constituents efficacious in dissolving oxidation products formed from the deposited metal, and in some cases I may also incorporate in the coating reducing and degasifying agents to counteract the effect of gases which, in spite of the slag blanket already referred to, come into contact with the molten metal.

The invention may be embodied in a rod having a coating of manganese silicate applied thereto in any suitable way as by powdering it, mixing the powder with a binder such as dilute alcoholic shellac, immersing the rod in the mixture, and then withdrawing the rod and allowing the adherent material to harden. The manganese silicate may more or less closely approach the composition represented by the formula $MnO.SiO_2$, but an excess of either manganese oxide or silica may be present.

Instead of preformed manganese silicate the coating may contain material adapted to react at the temperature of the metal-depositing operation to produce manganese silicate. This is the preferred form of the invention as it permits one operation to be dispensed with. The coating may contain for example an oxide ore of manganese and any finely divided form of silica. As in the case of the preformed silicate the proportions may be such that $MnO.SiO_2$ or a more basic or acidic silicate will be formed.

Under some conditions it is desirable to replace the manganese oxide with a composition containing manganese in unoxidized condition, such as manganese metal or a manganese alloy. The greater portion of the manganese present in the coating will usually be oxidized during the depositing operation and the oxide formed will be immediately available for the formation of manganese silicate. Unoxidized manganese when present in the coating produces a strongly deoxidizing condition to which the molten metal is subjected and this favors the deposition of sound metal.

Likewise the silica may be replaced by unoxidized silicon, either as commercially pure elemental silicon or as a silicon alloy. Silicon, as is well known, is a powerful deoxidizing agent, and its oxidation product (silica) will combine with any manganese oxide present to form the desired silicate.

I prefer to have manganese present in the coating in both oxidized and unoxidized form, and also prefer to have both unoxidized

silicon and silica. Desirable reducing conditions are thus established while a blanket of manganese silicate slag is produced more promptly and abundantly than when preformed manganese oxide and silica, or their equivalent, are absent. By having both manganese and silicon present in unoxidized form the reducing conditions referred to may be maintained without disturbing the balance between manganese oxide and silica. If only one of these elements were present in unoxidized form it will be apparent that the proportion of its oxide present would increase as the oxidation of the element in situ progressed. An advantageous proportion of silicon to manganese in the unoxidized portion of the coating material is about one weight to three.

The unoxidized manganese and silicon can be supplied as a single alloy which may contain in addition to these elements any others which are desirable or harmless. For example an alloy of manganese, silicon, and magnesium may be used, the powerful degasifying action of magnesium being thus brought into play.

It is sometimes desirable to add to the coating an auxiliary flux. Borosilicate glass, for example, is in the molten condition an active solvent for oxides which may be formed from the deposited metal during welding. It takes up chromium oxide with great avidity and is found to be a valuable addition to the coating of a chrome-iron welding rod. Sodium borosilicate glass may be made by fusing borax with silica. Two weights of crystallized borax to one of silica gives a good glass, but the proportions may be varied in either direction. Instead of using a preformed glass, borax, preferably previously dehydrated, and silica may be added to the coating, as the heat of the welding operation will bring about a reaction between them.

Example I

In a specific experiment low carbon steel rods containing not more than 0.10% carbon and not more than 0.15% manganese were coated with a mixture constituted as follows:

Material	Parts by weight
Manganese ore	35
Silica flour	20
Ferromanganese	27
Ferrosilicon	8

The manganese ore contained the equivalent of 73% MnO and 4% SiO_2. The manganese alloy contained 84% Mn and the silicon alloy contained 92% Si. The whole mixture was so proportioned that MnO and SiO_2 were present about as required by the formula $MnO.SiO_2$, and the proportion of unoxidized manganese to unoxidized silicon was about three to one. The rods were used in making oxy-acetylene welds of the single V type. No difficulty was experienced in the welding operation. The average tensile strength of the welds was about 55000 pounds per square inch whereas 45000–47000 per square inch is considered average strength for welds made in the same way with uncoated rods of the same composition. The weld metal had a manganese content of 0.23%.

Example II

In another experiment standard steel electrodes were coated with the mixture described above and used for making welds electrically. The strength and ductility of the welds were decidedly better than when the same electrodes were used without the coating.

Example III

Chrome-iron wires one-eighth inch in diameter and containing 26% chromium were coated with a large variety of mixtures falling within the present invention and tested on electrical welding using 100 amperes at 60 volts. The results were very satisfactory. Excellent results were given by wires coated with the following mixture

Material	Parts by weight
Manganese ore	35
Silica	20
Mn-Si alloy	35

The manganese ore had the composition given under Example I. The manganese-silicon alloy contained Mn 58%, Si 18%.

Example IV

The procedure of Example III was repeated using the coating mixture of Example I. The results were as satisfactory as in Example III.

Exampe V

The procedure of Example III was repeated using a coating containing equal parts of silica flour, sodium borosilicate glass and a manganese-magnesium-silicon alloy. The glass was made by fusing two weights of crystallized borax with one weight of silica. The alloy had approximately the following composition:

	Per cent
Magnesium	8.5
Manganese	46.3
Silicon	32.8
Iron	7.0
Carbon	0.4

The results were satisfactory but inferior to those of Examples III and IV.

Example VI

The procedure of Example III was repeated using a coating containing:

	Parts
Silica flour	90
Mg-Mn-Si alloy	10

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3

The alloy was the same as in Example V and the results were of the same kind as those obtained in Example V.

The foregoing description refers specifically to rods or electrodes having an external coating of slag-forming materials. A hollow rod containing the slag-forming materials as a core is the equivalent of the externally coated article, and may be regarded as an internally coated rod. The appended claim is intended to embrace all rods or the like wherein an elongated metal member and an elongated body of slag-forming material are so juxtaposed that additional slag or flux is automatically supplied as the extremity of the metal member is fused away.

The compositions described herein for coating welding rods or electrodes can also be used, though usually not so advantageously, in forms other than a coating or core. They may, for example, be used in the form of powder into which the hot rod or electrode may be dipped, or they may be applied to the weld in any other suitable way. The use in welding of the compositions claimed in the appended claim is included in my invention, whether or not the composition is applied to the rod as a coating.

This application is a continuation-in-part of an application filed by me on September 22, 1925, Serial No. 57,944.

I claim:

The process of welding ferrous metals which comprises fusing the metal and depositing the same under a molten slag containing manganese silicate, and introducing into said fused slag an unoxidized element of said silicate at such a rate that the deposited metal is effectually degasified and the fluidity of the slag is not destroyed.

In testimony whereof, I affix my signature.

WILBER B. MILLER.

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Nov. 18, 1930. B. S. ROBINOFF ET AL 1,782,316

METHOD OF WELDING

Filed May 10, 1929

Fig. 1.

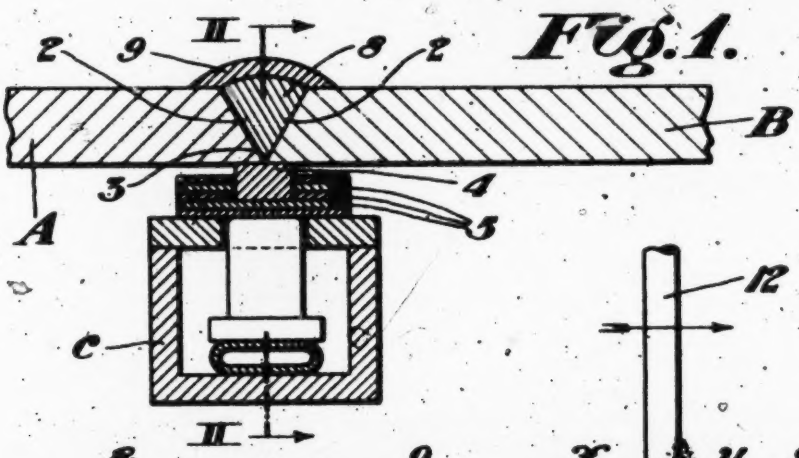


Fig. 2.

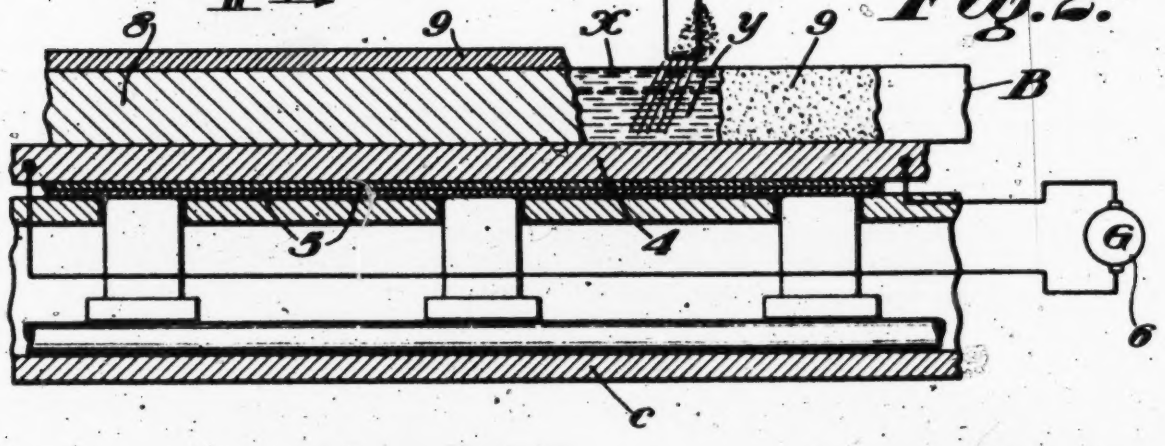


Fig. 4.

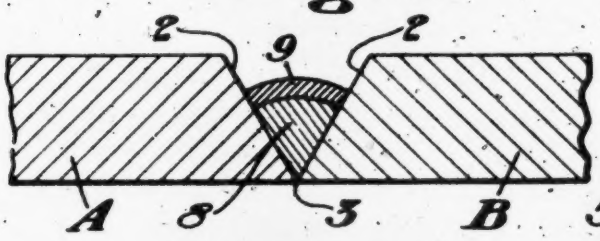


Fig. 3.

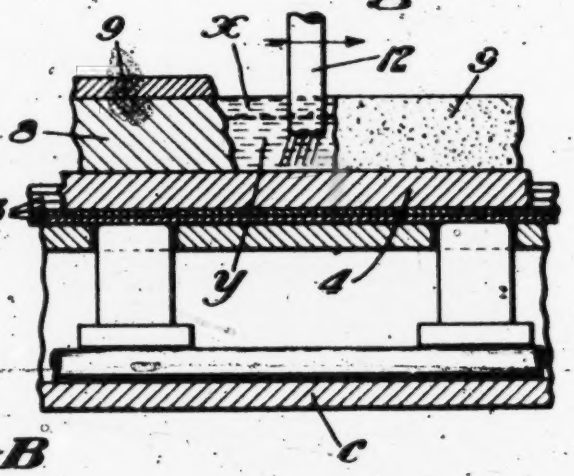
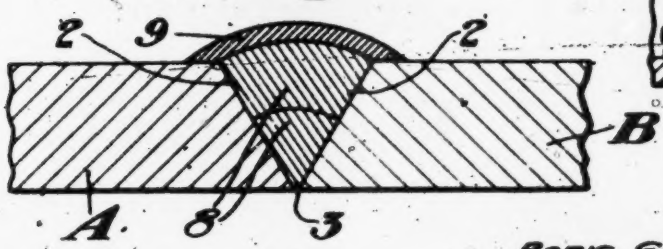


Fig. 5.



Inventors:

BORIS S. ROBINOFF, SUMNER E. PAINE and WRIGNOL E. QUILLEN.

by: Usina & Rauber

their Attorneys.

Patented Nov. 18, 1930 1,782,316

UNITED STATES PATENT OFFICE

BORIS S. BORINOFF, OF PITTSBURGH, AND SUMNER E. PAINE AND WRIGNOL E. QUILLEN, OF McKEESPORT, PENNSYLVANIA, ASSIGNORS TO NATIONAL TUBE COMPANY, A CORPORATION OF NEW JERSEY

METHOD OF WELDING

Application filed May 10, 1929. Serial No. 362,040.

This invention relates to methods of welding and while not limited thereto relates particularly to a method of forming continuous seam welding, such as when forming large cylindrical articles like pipe, tanks, etc.

One of the objects of the present invention is to provide a novel method, by which the metal deposited during the welding operation is prevented from oxidizing by maintaining a heavy covering or layer of flux or slag on the molten metal. This cover of slag or flux also serves to maintain the deposited metal molten for sufficient time to permit all gases to escape from the molten metal whereby a non-porous depositing of molten metal results.

Another object is to provide a method by which continuous weld rods of any length may be used thereby permitting a continuous weld of any length.

Heretofore weld rods have generally been coated with a flux material and such rods cannot be reeled since reeling will break off the flux; therefore, the length of such rods and consequently the length of the continuous welds is limited.

A further object is to provide a method whereby the flux is caused to be attracted and adhere to the electrode by magnetic forces as the electrode is fed toward the point of weld.

In carrying out our method the edges of the plate or plates to be welded are first chamfered and then brought into an abutting position to form a U or V-shaped groove along the line of weld. The plate or plates are then positioned over a suitable backing up bar standard welding apparatus and clamped in their abutted position. The groove is then filled with a powdered flux composition having a percentage of ground or powdered scale (ferrous oxide) to make the flux magnetizable.

After the groove has been filled with flux the welding head of the welding machine, having a reel of welding rod or electrode wire thereon, is started in operation to feed the electrode down into welding position with respect to the flux filled groove and also to feed the electrode longitudinally of the groove. After the electrode is brought into proper position an arc will be struck so as to melt the flux in the groove and also to melt the metal of the electrode so as to furnish a deposit of metal in the groove.

As the welding operation progresses the welding rod will be continually melted and deposit the molten metal through the molten flux in the groove, and the metal being of greater specific gravity than the molten flux will cause the flux to rise in the groove as the metal is deposited. The movement of the welding head is so timed that the proper amount of molten metal will be deposited to fill the groove the desired amount as the head pases along the groove.

In carrying out this method the molten metal deposited from the electrode is at all times covered by a layer of the flux in the form of a slag and therefore the deposited metal from the electrode will remain molten a sufficient time to permit any entraining gases to escape and the deposited metal will not become oxidized since the flux or slag protects the molten metal from the atmosphere.

In the drawings:

Figure 1 shows the edges of a pair of plates with a finished weld joining them and with the flux or slag covering the welded joint.

Figure 2 is a longitudinal section through a joint being welded by the preferred method of this application.

Figure 3 is a similar view to Figure 2 showing a slightly modified method for carrying out our invention.

Figure 4 is a sectional view showing a pair of heavy plates which have been partly joined by the methods of this application.

Figure 5 is a view similar to Figure 4 showing the same plates as shown in Figure 4 with the welded joint completed.

Referring more particularly to the drawings which illustrate generally the method of and apparatus for carrying out our invention, the letters A and B designate the work-pieces to be joined which may be separate plates or the opposite edges of a tubular ob-

ject such as a pipe, tank, etc., formed from a single plate.

The edges of the work to be joined or seamed are chamfered or beveled as at 2 and are forced together so as to form a V-shaped groove 3. After the work is thus prepared it is mounted on a welding beam *c* of a welding machine having a backing up bar 4 of copper and around which are mounted iron plates 5. The bar 4 is connected to a source of current such as the generator 6 and the current passing through the bar 4 serves to magnetize the plates 5 and form a magnetic field along the line of weld.

The V-shaped groove is then filled with a flux 9 having a ferrous metal scale content sufficient to make it magnetic, and the joint or seam is then in readiness for welding.

The operation of welding from this point may be carried out in several ways all of which retain the one fundamental feature of maintaining a relatively heavy coating of flux or slag 9 on top of the molten welding metal and through which the molten metal is deposited so as to prevent oxidation of the metal.

In Figure 1 a completed seam weld is shown in which the deposited metal 8 is shown covered by the layer of flux or slag 9.

In Figure 2 the section is taken through the weld and shows the welding method of this invention in operation. At the left hand of this figure the weld is shown completed, while at the center the weld is being made and at the right-hand end the groove 3 is shown filled with flux.

After the groove 3 is filled with flux, the metal electrode 12, which is preferably plain uncoated rod mounted on a reel carried by the welding head (not shown), is moved into position to strike an arc with the side-walls and bottom of the groove 3. When the arc is thus struck the welding current will flow from a suitable source through the rod and work and the rod will become magnetized so as to attract the flux 9. The flux thus attracted will be melted by the arc and form a molten slag in the groove 3. The electrode is then continually fed down toward the work and forwardly along the groove 3 at a speed timed so as to deposit the required amount of welding metal in the groove 3 and also so that the flux is always spaced in advance of the electrode. The flux will be continually attracted by the electrode 12 and will be melted so as to maintain a body of molten flux *x* in said groove below the electrode through which the molten welding metal is deposited forming a pool *y*. The body of flux in advance of the electrode serves as a dam and thereby permits the building up of the molten welding metal and flux or slag. As the welding operation progresses the deposited metal and its covering of slag solidifies, but said slag will maintain said metal molten until all gases have escaped and also said slag will prevent any oxidation of the deposited metal.

The magnetic field formed along the line of weld serves to control the arc and the deposit of molten metal so that the metal is deposited to the rear of the arc rather than in advance of the arc as would otherwise be the case. It also probably serves to magnetize or pre-charge the magnetizable flux so that said flux is more readily attracted by the electrode.

In Figure 3 a modified method of this invention is disclosed. In this modified method the electrode 12 is caused to move down into the body of flux 9 and is then moved forward at a speed to maintain the electrode in close position relative to the flux thereby causing said flux to be melted directly by the arc.

When welding the thinner gages of work the groove 3 will be completely filled as shown in Figure 1 in one operation, however, when welding heavy gage work the method illustrated in either Figures 2 or 3 will be preferably used to partly fill the groove 3 as shown in Figure 4, and the flux or slag covering is then removed by power chisels or the like and the remaining portion of the groove will then be again filled with flux and a second welding operation will be used to completely fill the groove 3 as shown in Figure 5.

In the practice of either modification of the above method a continuous electrode is used so that the welding operation may be carried on continuously as contrasted to the interrupted operations necessary when using the relatively short coated electrodes of the prior art. This feature alone results in a superior weld over the welds of the prior art with their many joints caused by the successive use of the relatively short electrodes.

Furthermore the practice of either modification of the method of this invention eliminates the oxidation of the deposited metal, while the coated electrodes of the prior art do not provide a continuous body of molten flux to protect the molten metal and maintain said metal molten until the gases escape therefrom.

While we have described and illustrated certain specific embodiments of our invention it will be understood that we do not wish to be limited to the specific steps or sequence of steps described since various modifications may be carried out without departing from the scope of our invention as described in the appended claims.

We claim—

1. In a method of seam welding the steps of first forming a groove along the seam to be welded, filling said groove with flux, causing said flux to become molten, and depositing the welding metal through said molten flux

so as to cause said flux to rise over and form a layer on said metal.

2. The method of forming continuous seam welding, which consists in providing a body of magnetizable flux along the seam to be welded, moving a metal electrode along said seam so as to draw an arc and melt said electrode and cause the molten metal from said electrode to deposit along said seam, and causing said flux to be attracted to said electrode during said welding operation by magnetic forces, said flux being melted by the welding arc to form a slag covering over the molten metal.

3. In a method of seam welding these steps of first forming a groove along the seam to be welded, filling said groove with a magnetizable flux, then moving a metal electrode along said seam so as to draw an arc and melt said electrode, and causing said flux to be attracted to said electrode by magnetic forces, said flux being melted by said arc so as to form a covering of flux over the molten metal deposited from said electrode.

4. In a method of welding, the steps of providing a magnetic field along the line of weld, providing a body of magnetizable flux within said field, and then moving a metal electrode along said line of weld so as to draw an arc and with sufficiently close proximity to said flux that said flux will be attracted to said electrode so as to continually coat said electrode with flux.

5. The method of forming continuous seam welds which consists in providing a controllable magnetic field along the seam to be welded, providing a body of magnetizable flux within said magnetic field, moving a metal electrode along said seam so as to draw an arc and melt the said electrode, and causing the melted metal from said electrode to deposit along said seam, said flux being attracted to said electrode and being melted by said arc so as to form a covering of flux over the molten metal deposited from said electrode.

6. The method of forming continuous seam welds which consists in providing a controllable magnetic field along the seam to be welded, providing a body of magnetizable flux within said magnetic field, moving a metal electrode along said seam so as to draw an arc and melt the said electrode, and causing the melted metal from said electrode to deposit along said seam, controlling the movement of said electrode so that said electrode will be constantly spaced a short distance from said body of flux, said flux being attracted to said electrode and being melted by said arc so as to form a covering of flux over the molten metal deposited from said electrode.

7. The method of forming continuous seam welds which consists in forming a groove along the seam to be welded, providing a controllable magnetic field along said seam, depositing a quantity of magnetizable flux in said groove, moving a metal electrode along said seam toward said flux so as to draw an arc and melt said electrode, and causing the melted metal from said electrode to deposit in said groove, said flux being attracted to said electrode and being melted by said arc so as to form a covering of flux over the molten metal deposited from said electrode.

8. In a method of seam welding the steps of first forming a groove along the seam to be welded, then depositing a body of flux in said groove, and then moving a metal electrode along said groove and drawing an arc causing said flux to melt and melting said electrode so as to deposit the molten metal from said electrode through said melted flux.

In testimony whereof, we have hereunto set our hands.

BORIS S. ROBINOFF.
SUMNER E. PAINE.
WRIGNOL E. QUILLEN.

DEFENDANTS' EXHIBIT NO. 137.

March 28, 1939. L. T. JONES 2,152,194

ELECTRIC WELDING

Filed April 17, 1936

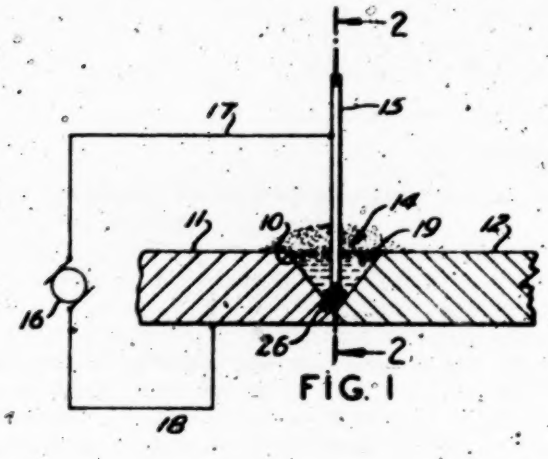


FIG. 1

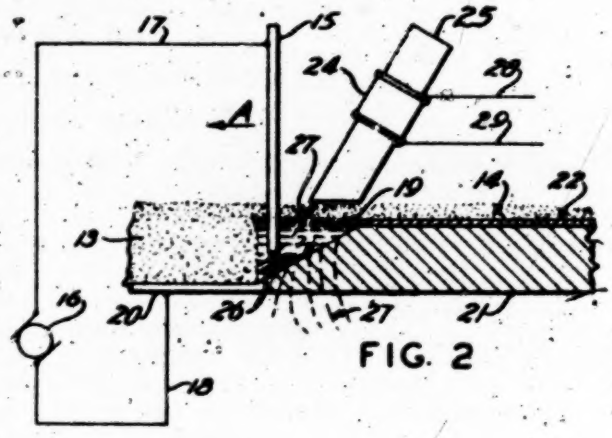


FIG. 2

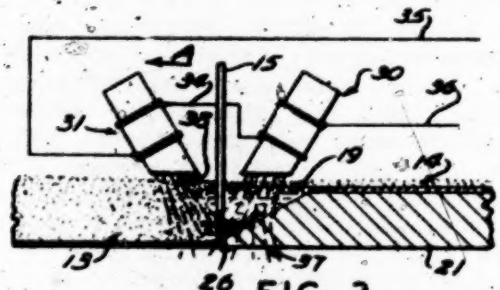


FIG. 3

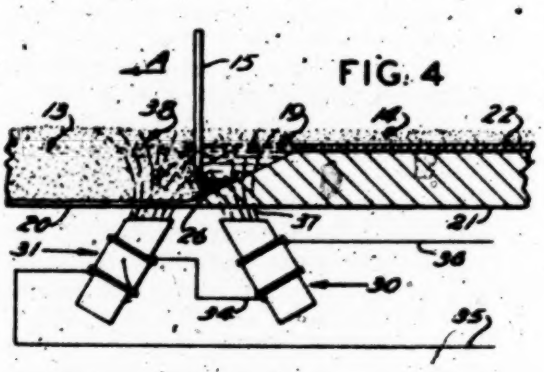


FIG. 4

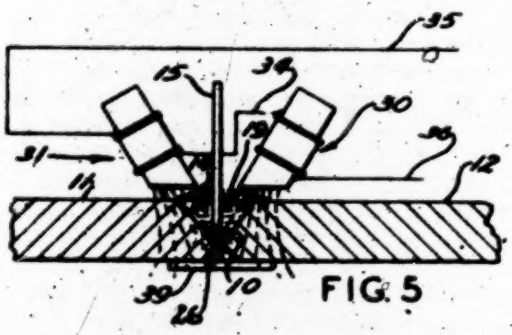


FIG. 5

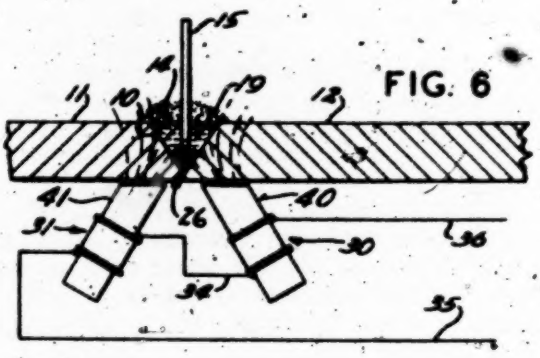


FIG. 6

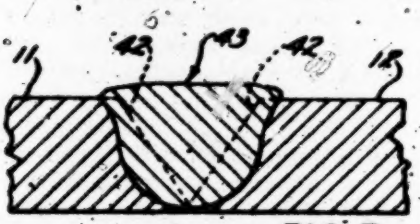


FIG. 7

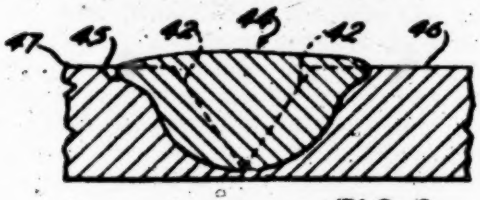


FIG. 8

U. S. DISTRICT COURT
NORTHERN DISTRICT OF INDIANA

INVENTOR
LLOYD T. JONES
BY
ATTORNEY

Patented Mar. 28, 1939 2,152,194

UNITED STATES PATENT OFFICE

2,152,194

ELECTRIC WELDING

Lloyd T. Jones, Berkeley, Calif., assignor to Union Carbide and Carbon Research Laboratories, Inc., a corporation of New York

Application April 17, 1936, Serial No. 74,849

11 Claims. (Cl. 219—10)

This invention relates to electric welding and the product produced thereby.

In Patent No. 2,043,960, issued to Lloyd T. Jones, Harry E. Kennedy and Maynard A. Rotermund jointly, on June 9, 1936, there is described and claimed a method of electric welding wherein the seam between the opposing edges of objects or work to be welded is filled with a welding composition in powdered or granular form, and the welding circuit is completed from an electrode or welding wire to the work through the welding composition into which the fusing end of the electrode is inserted. During a welding operation, as the electrode is fed to the work and simultaneously moved along the seam through the welding composition, the latter is locally fused at successive portions of the seam and forms a high resistance conductive path which supplies heat to fuse the end of the electrode and edges of the seam so that the molten metal from the electrode is deposited in the seam and coalesces with the fused edges thereof to provide a sound weld of uniform quality.

For any particular welding operation, the quality and type of weld produced is dependent upon several factors which include the penetration or extent of fusion of the edges of the objects being welded, the composition of the welding material or melt, the voltage and current employed, and the welding speed. When the desired welding speed is determined for a particular welding operation, a weld of desired width is produced. If the current and voltage remain constant and the welding speed is increased, the width of the weld produced decreases. Thus the decreasing width of the weld with increasing welding speed, the current and voltage of the welding circuit remaining constant, is one of the limiting factors to the maximum welding speed that can be attained.

In order to increase welding speeds, therefore, it has been necessary to increase the welding current to provide higher current densities at the welding zone. In many instances, it has generally not been desirable to increase the current density at the welding zone because objectionable and excessive penetration occurs at the lower edges of the seam or at the bottom of the welding groove. This is especially true when welding work wherein the bottom of the seam or groove is close to the underside or opposite face of the work, and also when welding relatively thin plates wherein the depth of penetration at the bottom of the weld becomes altogether too great with high current densities.

The object of this invention is to provide a method of controlling the deposition of metal on work in the process of electric welding wherein the welding is effected by the heat supplied by a highly fluid welding composition or melt which is in contact with both the fusing end of the electrode and the work.

The above and other objects and advantages of this invention will become apparent from the following description and accompanying drawing, in which:

Fig. 1 is a transverse section of a seam formed between the opposing beveled edges of plates to be welded, and diagrammatically illustrates the welding zone and welding circuit;

Fig. 2 is a longitudinal section of the seam shown in Fig. 1, and diagrammatically illustrates an electromagnet positioned over the seam adjacent the welding zone;

Fig. 3 is a longitudinal section of a seam similar to that shown in Figs. 1 and 2 with electromagnets positioned over the seam at the completed and uncompleted sides of the weld;

Fig. 4 is another longitudinal view of a seam similar to that shown in Figs. 1 and 2 with electromagnets positioned at the underside of the plates at the completed and uncompleted sides of the weld;

Fig. 5 is a transverse section of a seam similar to that shown in Fig. 1 with electromagnets disposed above the work at opposite sides of the seam adjacent the welding zone;

Fig. 6 is a transverse section of a seam similar to that shown in Fig. 5 and illustrates electromagnets positioned at the underside of the plates at opposite sides of the seam; and

Figs. 7 and 8 diagrammatically illustrate the character of the completed welds produced when the welding is accomplished without a magnetic field adjacent the welding zone and with a magnetic field adjacent the welding zone, respectively.

In the following description, like parts in the different figures of the drawing are designated by the same reference numerals. Referring to Figs. 1 and 2 which illustrate the process of electric welding disclosed in the patent referred to above, the groove or seam 10 formed between the opposing beveled edges of plates 11 and 12 adapted to be welded is filled with a high resistance welding composition 13 in powdered or granular form. Preferably an ample quantity of this material is used so that it forms a mound 14 extending lengthwise of the seam. An electrode 15 is inserted into the welding composi-

tion in the manner shown in Fig. 1, so that it is spaced from the plates 11 and 12. The welding circuit may comprise a source of electric energy 16 and conductors 17 and 18 connected to the electrode and work, respectively.

In order to complete the welding circuit to start a welding operation, suitable material, such as steel wool, is provided to bridge the gap between the end of the electrode 15 and the plates 11 and 12. The flow of current between the electrode and the work heats a region of the welding composition 13 so that it fuses and becomes a high resistance conductive path, and this region of fused or liquid material supplies heat to fuse the end of the electrode 15 and the edges of the plates 11 and 12. The molten metal deposited from the electrode coalesces with the fused edges of the plates, and the fused material and molten metal occupy the entire space forming the welding zone.

The electrode 15 is continuously fed toward the work and, after an interval of time, is moved along the seam 19 and through the welding composition or melt 13 at a uniform speed. At successive portions of the seam, the granular material 13 is locally fused and becomes highly fluid and superheated, as indicated at 19 in Fig. 2, whereby the liquid currents produced effectively mix the molten metal and welding composition to wash impurities out of the metal and separate the latter as it solidifies as an integral element of the plates being united. The progress of the welding operation is shown in Fig. 2 with the electrode 15 moving relatively to the work in the direction indicated by the arrow A. The welding composition 13 at the unwelded portion 20 of the seam ahead of the electrode 15 is in a powdered or granular state, while at the welded portion 21 of the seam the fused material has risen to the top of the weld and solidified, as shown at 22. In the welding operation just described, the excess amount of granular material, indicated at 14, remains unfused and covers the solidified layer 22.

In accordance with the present invention the deposition of electrode metal is controlled by providing a magnetic field which is adapted to displace or alter the lines of flow of current in the welding zone 19 comprising highly fluid welding composition and fused metal. By altering the flow of current in the welding zone, it has been possible to decrease the depth of penetration or fusion at the lower edges of a seam or bottom of a groove formed at the opposing edges of plates or objects to be welded, so that higher current densities and welding speeds can be effectively and safely employed without impairing the quality of the resultant weld produced.

One manner of practicing the present invention is shown in Fig. 2, wherein an electromagnet comprising a winding 24 and a core 25 extending therethrough is disposed adjacent the electrode 15 at the completed side 21 of the weld. The core 25 is positioned above the welding zone 19 and inclined toward the electrode 15 at an acute angle to the plates 11 and 12. In order to position the core 25 as close as possible to the plates 11 and 12, the lower end of the core is preferably beveled.

The lines of flow of current in the fluid welding composition and fused metal are indicated by the dotted lines 26, and extend downward and rearwardly of the electrode 15. The lines of magnetic flux due to the electromagnet, indicated by the broken lines 27, extend downward from the core 25 and intersect and are substantially perpendicular to the lines 26 indicating the flow of current. When an alternating current is supplied to the conductors 17 and 18 and the winding 24 of the electromagnet is connected through conductors 28 and 29 to a direct current source of supply, the magnetic field due to the electromagnet will be of substantially uniform intensity and effective to deflect the flow of alternating current in the fluid welding composition and fused metal alternately to one side and then the opposite side of the normal current path. When the lines of flow of current are disturbed and deflected, the new current path increases the temperature of the molten welding composition and fused metal in this path. This increase in temperature of the molten welding composition and fused metal in the new path effects additional heating at one side of the normal path and decreases the resistance to the flow of current in this new path. With this deflection of the lines of flow of current, the temperature of the welding composition and fused metal in the previous path immediately decreases so that the resistance of the previous path of current increases. Since the welding composition and fused metal in the new path of current flow becomes more conductive with heating, the lines of flow of current are readily deflected and shifted by the action of the magnetic field.

In deflecting the lines of flow of current alternately from one side to the opposite side of the normal current path, the path of flow of current is widened considerably, the only limitation being the boundary of the fluid welding composition and fused metal forming the welding zone 19. Although the path of flow of current is widened, the resistance of the fluid welding composition and fused metal as a whole remains substantially unchanged. Since the path of flow of current is widened, however, the heating generated or developed within the fluid welding composition is such that the depth of penetration or fusion at the lower portions of the edges of the plates or objects is diminished and there is less concentration of energy at the surface of the plates or objects opposite to that having the welding seam or groove.

With the electromagnet positioned at the completed side of the weld and maintained adjacent to the electrode 15 during its movement relative to the work, as shown in Fig. 2, the magnetic field is effective to decrease the depth of penetration or fusion at the lower portions of the edges of the plates and to increase the depth of penetration along the remaining portions of the edges of the plates toward the top surfaces of the plates. In this manner the depth of the resultant weld produced is effectively controlled and the width of the weld is increased. The intensity of the magnetic field provided determines the extent to which the lines of flow of current in the welding zone 19 are deflected, and this intensity may be controlled by varying the current supplied to the coil 24 of the electromagnet and the position of the core 25 with respect to the work surface. The polarity of the electromagnet does not appear to be of any particular importance, the same result being obtained when the lower end of the core 25 is either a north or south pole.

It has been found that the depth of penetration at the lower portions of a seam or bottom of a groove can be decreased when the electromagnet is placed in any position where the lines of flux of the magnetic field will intersect the lines of flow of current in the welding zone 19 and deflect or

alter the path of current flow in the molten welding material and fused metal. In Fig. 3, for example, two electromagnets 30 and 31 are positioned above and parallel to the seam at the completed and uncompleted sides 21 and 20, respectively, of the weld. The electromagnets 30 and 31 may be connected in series relation through a conductor 34, and to a suitable source of electric energy through conductors 35 and 36. In this embodiment the lines of magnetic flux 37 and 38 extend obliquely downward into the welding zone 19 and intersect the lines of flow of current 26 in the molten welding material and fused metal to deflect and alter the lines of flow of current.

Instead of positioning the electromagnets 30 and 31 above the work, as shown in Fig. 3, these electromagnets may be positioned parallel to the seam at the underside of the work. Such an arrangement is shown in Fig. 4 with the electromagnets 30 and 31 positioned parallel with the seam being welded and at opposite sides of the electrode 15. In this embodiment, as in that just described and shown in Fig. 3, the lines of flux 37 and 38 are effective to intersect and deflect the lines of flow of current in the molten welding material and fused metal at the welding zone.

The depth of penetration at the lower portions of a seam or bottom of a groove has also been decreased by providing a magnetic field which is transverse to the direction of welding, the electromagnets being disposed either above or below the work surface. In Fig. 5 is shown one such arrangement with electromagnets 30 and 31 disposed above the plates 11 and 12 at opposite sides of the seam 18 adjacent the welding zone 19. In many instances a backing-up bar 39 is employed, such bar being maintained in position at the seam against the underside of the work.

Sometimes it is not possible to employ a backing-up bar, and in such instances it has been found desirable to employ electromagnets positioned at the underside of the work surface to limit the depth of penetration at the lower portions of the seam. This modification is shown in Fig. 6 with the electromagnets 30 and 31 arranged transverse to the seam 18 and at opposite sides of the welding zone 19. Although the cores 40 and 41 of these electromagnets may be spaced from the plates 11 and 12, it may sometimes be desirable to position the electromagnets so that the cores almost but not quite contact the underside of the plates. This is particularly advantageous when no backing-up bar is employed because, as the depth of penetration of the weld tends to increase at the lower portions of the seam, the lines of flow of current in the welding zone approach the portion of the magnetic field of greatest intensity. In this manner it is possible to control or limit automatically the depth of penetration of the weld at the bottom of the seam.

Experiments which have been carried out conclusively prove that the provision of a magnetic field, as described above, permits precise control of the deposition of metal on metallic surfaces. When a weld was made on a solid plate ½ inch in thickness at a welding speed of 12 inches per minute without employing a magnetic field, the voltage and current of the welding circuit being 40 volts and 880 amperes, respectively, the depth of penetration of the weld vertically into the plate was 0.360 of an inch and the width of the resultant weld was 0.730 of an inch. By providing a direct current magnetic field in the manner shown in Fig. 2 and described above, it was possible to decrease the depth of penetration vertically into the plate to 0.140 of an inch and to increase the width of the resultant weld to 0.950 of an inch.

The advantages of providing a magnetic field to decrease or limit the depth of penetration of the weld at the bottom of a seam or groove can be indicated in the welding of steel plates about ¼ of an inch thick. When no magnetic field is employed, a welding current of 400 amperes produces a depth of penetration at the bottom of the seam which is relatively high for welding plates of this thickness. When a magnetic field is provided to decrease the depth of penetration of the weld toward the underside of the plates, it has been possible to employ welding currents as high as 1100 amperes without producing excessive penetration; and at these higher values of welding current the speed of welding is increased tremendously.

The fact that the lines of flow of current in the welding zone readily move and deflect from the normal current path, when under the influence of a magnetic field, is believed to be due to the fact that the molten welding composition and fused or molten metal occupy the entire space of the welding zone, so that the molten welding composition is constantly maintained in contact with the fusing end of the electrode and the fused edges of the objects to be united. The moving of the lines of flow of current in the molten welding composition and fused metal is similar to the Hall effect, wherein the lines of flow of current are magnetically displaced in an electrical conductor. Whereas the flow of current can readily be deflected and altered in the molten welding composition and fused metal, as described above, the lines of flow of current in a conductor can be so displaced only a relatively small amount because the new path of flow of the current is necessarily a higher resistance path and the previous path of lower resistance is always available.

The result produced by the magnetic field in the process of welding described above is entirely different from that produced when a magnetic field is employed in electric arc welding. Regardless of the manner in which a magnetic field is employed with electric arc welding, it has never been possible to increase the width of an arc weld or to reduce the depth of penetration at the lower portions of the weld. In electric arc welding the use of a magnetic field tends to decrease the width of the resultant weld and increase the depth of penetration at the bottom of the weld. Under the same operating conditions as in the first example given above, the use of the magnetic field in electric arc welding with an uncoated welding rod decreased the width of the resultant weld from 0.800 to 0.520 of an inch and increased the depth of penetration of the weld vertically into the plate from 0.280 to 0.290 of an inch. On the other hand, it has never been possible to increase the depth of penetration at the bottom of the weld or decrease the width of the welding when employing a magnetic field with the present welding process in which the welding heat is derived from the superheated molten welding material at the welding zone.

In carrying out the present welding process with the use of a magnetic field, it is imperative that a welding composition be used in which the chemical reactions between the constituent ele-

ments have been completed so that the welding material or melt is chemically inert and will not evolve deleterious amounts of gases during the welding operation. Further, the fluidity of the welding material or melt at the welding temperature should be such that it will not become entrained with the molten metal. The principal ingredients of the high-resistance welding material or melt preferably used consist of silica, one or more silicates of alkaline earth metals, and alumina, and these ingredients are prefused in any suitable manner, as in an electric furnace. A halide salt, such as calcium fluoride, may be added to the mixture before or after the other ingredients have been fused and cooled. The molten mixture is preferably cooled rapidly in such a manner that the solidified material is characterized by a vitreous luster on fracture. It is important that the material, after cooling and grinding, be substantially free from iron oxides uncombined with other ingredients of the composition and from other materials, such as carbonates or moisture, which evolve detrimental amounts of gas or vapor at welding temperatures. The analyses by weight of representative melts which have been successfully used in practicing the present invention are given below. These melts have a negative temperature coefficient of electrical resistance:

Percent of	I	II	III	IV
CaO	28.5	31.24	28.18	40.13
MgO	5.7	11.01	5.28	0.89
SiO_2	56.4	52.40	57.48	52.94
Al_2O_3	5.4	4.11	4.26	5.80
Fe_2O_3	Low	0.13	0.24	0.23

Before use, about 1 part of calcium fluoride was added to 16 parts, by weight, of each of the above compositions.

The characteristic types of welds produced when the above-described method of welding is employed without and with the provision of a magnetic field adjacent to the welding zone are diagrammatically illustrated in Figs. 7 and 8, respectively. The dotted lines 42 in these figures indicate the beveled edges at the opposing faces of the plates 11 and 12 which were formed preparatory to welding. In the weld 43 in Fig. 7, which was produced without the provision of a magnetic field, it will be seen that the sides of the completed weld are relatively steep, with the width of the weld at the top surfaces of the plates 11 and 12 being slightly greater than the width of the original seam. In the weld 44 in Fig. 8, which was produced with the magnetic field adjacent to the welding zone, the side walls of the completed weld have a greater slope than the side walls of the weld illustrated in Fig. 7. It will also be apparent that the depth of penetration at the bottom of the seam is less in Fig. 8 than in Fig. 7 and that the deflection of the lines of flow of current during the welding of the joint shown in Fig. 8 has effected greater penetration near the top portions of the plate edges and increased the width of the resultant weld considerably throughout its entire depth. A characteristic feature of the welds produced on flat and curved plates with a magnetic field adjacent the welding zone is the pronounced and decided lip formation 45 at the edges of the weld adjacent to the top surfaces of the plates 46 and 47.

In place of an electromagnet or electromagnets, one or more strong permanent magnets may be employed to deflect or move the lines of flow of the alternating current in the molten welding composition and fused metal at the welding zone. A permanent magnet of cobalt steel, for example, will in many instances provide a magnetic field of sufficient intensity to control the depth of penetration of the weld at the lower portions of a seam or groove, the adjustment of the field strength with a permanent magnet being obtained by changing the position of the magnet.

When alternating current is used in welding, control of the depth of the penetration of the weld at the lower portions of a seam may also be obtained by connecting the electromagnets to an alternating current source of supply to provide an alternating current magnetic field of such a character that the lines of flow of current are displaced or altered. In certain instances the winding of the electromagnet may be connected directly in the welding circuit to provide an alternating magnetic field of such a character that the depth of penetration of the weld is controlled. The magnetic field, either alternating or direct in character, may also be used when direct current is employed in the welding circuit. In each instance the magnetic field may be of such a character that it is effective to reduce the depth of penetration of the weld at the lower portions of a seam.

In view of the foregoing it will be seen that, by providing a magnetic field to decrease the depth of penetration of the weld, higher welding currents can be used, so that welding operations can be carried out at much greater speeds with the consequent economies in labor and overhead costs.

While different methods of practicing the present invention have been described and shown, it is intended that they shall be interpreted as illustrative of the scope of the invention and not in a limiting sense.

What is claimed is:

1. A method of electric welding which comprises providing an unbonded granular non-metallic material of high electrical resistance and having a negative temperature coefficient of resistance in full contact with all the surfaces to be united by welding; inserting an electrode into said material; passing, from said electrode through said material to said surfaces, an electric current of sufficient magnitude to melt progressively the portion of the electrode in said material and to heat and melt progressively a definite quantity of said material; and applying a magnetic field to such molten material in such a manner that the lines of flux of said magnetic field intersect the lines of flow of current in said molten material thereby to displace laterally said lines of flow of current to increase the lateral penetration of the welding heat in said surfaces and consequently to decrease the vertical penetration of the heat therein.

2. A method of electric welding which comprises providing an unbonded granular non-metallic material of high electrical resistance and having a negative temperature coefficient of resistance in full contact with all the surfaces to be united by welding; inserting an electrode into said material; passing, from said electrode through said material to said surfaces, an alternating electric current of sufficient magnitude to melt progressively the portion of the electrode in said material and to heat and melt progressively a definite quantity of said material; and

applying a magnetic field to such molten material in such a manner that the lines of flux of said magnetic field intersect the lines of flow of current in said molten material thereby to displace laterally alternately to one side and then to the opposite side said lines of flow of current to increase the lateral penetration of the welding heat in said surfaces and consequently to decrease the vertical penetration of the heat therein.

3. A method of electric welding which comprises providing an unbonded granular non-metallic material of high electrical resistance and having a negative temperature coefficient of resistance in full contact with all the surfaces to be united by welding; inserting an electrode into said material; passing, from said electrode through said material to said surfaces, an electric current of sufficient magnitude to melt progressively the portion of the electrode in said material and to heat and melt progressively a definite quantity of said material; applying a magnetic field to the resulting molten mass in such a manner that the lines of flux of said magnetic field intersect the lines of flow of current in said molten mass; and rapidly reversing the direction of said lines of flux thereby to displace laterally alternately to one side and then to the opposite side said lines of flow of current to increase the lateral penetration of the welding heat in said surfaces and consequently to decrease the vertical penetration of the heat therein.

4. A method of electric welding which comprises providing an unbonded granular non-metallic material of high electrical resistance and having a negative temperature coefficient of resistance in full contact with all the surfaces to be united by welding; inserting an electrode into said material; passing, from said electrode through said material to said surfaces, an electric current of sufficient magnitude to melt progressively the portion of the electrode in said material and to heat and melt progressively a definite quantity of said material; and applying a magnetic field rearwardly of said electrode in such a manner that the lines of flux of said magnetic field extend substantially parallel to said surfaces and intersect at right angles the lines of flow of current in the resulting molten mass thereby to displace laterally said lines of flow of current to increase the lateral penetration of the welding heat in said surfaces and consequently to decrease the vertical penetration of the heat therein.

5. A method of electric welding which comprises providing an unbonded granular non-metallic material of high electrical resistance and having a negative temperature coefficient of resistance in full contact with all the surfaces to be united by welding; inserting an electrode into said material; passing, from said electrode through said material to said surfaces, an alternating electric current of sufficient magnitude to melt progressively the portion of the electrode in said material and to heat and melt progressively a definite quantity of said material; and applying a magnetic field rearwardly of said electrode in such a manner that the lines of flux of said magnetic field extend substantially parallel to said surfaces and intersect at right angles the lines of flow of current in the resulting molten mass thereby to displace laterally alternately to one side and then to the opposite side said lines of flow of current to increase the lateral penetration of the welding heat in said surfaces and consequently to decrease the vertical penetration of the heat therein.

6. A method of electric welding which comprises providing an unbonded granular non-metallic material of high electrical resistance and having a negative temperature coefficient of resistance in full contact with all the surfaces to be united by welding; inserting an electrode into said material; passing, from said electrode through said material to said surfaces, an electric current of sufficient magnitude to melt progressively the portion of the electrode in said material and to heat and melt progressively a definite quantity of said material; applying a magnetic field rearwardly of said electrode in such a manner that the lines of flux of said magnetic field extend substantially parallel to said surfaces and intersect at right angles the lines of flow of current in the resulting molten mass; and rapidly reversing the direction of said lines of flux thereby to displace laterally alternately to one side and then to the opposite side said lines of flow of current to increase the lateral penetration of the welding heat in said surfaces and consequently to decrease the vertical penetration of the heat therein.

7. A method of electric welding which comprises providing an unbonded granular non-metallic material of high electrical resistance and having a negative temperature coefficient of resistance in full contact with all the surfaces to be united by welding; inserting an electrode into said material; passing, from said electrode through said material to said surfaces, an electric current of sufficient magnitude to melt progressively the portion of the electrode in said material and to heat and melt progressively a definite quantity of said material; and applying a magnetic field from a point above said surfaces to the resulting molten mass in such a manner that the lines of flux of said magnetic field extend substantially parallel to said surfaces and intersect at right angles the lines of flow of current in said molten mass thereby to displace laterally said lines of flow of current to increase the lateral penetration of the welding heat in said surfaces and consequently to decrease the vertical penetration of the heat therein.

8. A method of electric welding which comprises providing an unbonded granular non-metallic material of high electrical resistance and having a negative temperature coefficient of resistance in full contact with all the surfaces to be united by welding; inserting an electrode into said material; passing, from said electrode through said material to said surfaces, an electric current of sufficient magnitude to melt progressively the portion of the electrode in said material and to heat and melt progressively a definite quantity of said material; and applying a magnetic field from beneath said surfaces to the resulting molten mass in such a manner that the lines of flux of said magnetic field intersect at right angles the lines of flow of current in said molten mass thereby to displace laterally said lines of flow of current to increase the lateral penetration of the welding heat in said surfaces and consequently to decrease the vertical penetration of the heat therein.

9. A method of electric welding which comprises providing an unbonded granular non-metallic material of high electrical resistance and having a negative temperature coefficient of resistance in full contact with all the surfaces to

be united by welding; inserting an electrode into said material; passing, from said electrode through said material to said surfaces, an electric current of sufficient magnitude to melt progressively the portion of the electrode in said material and to heat and melt progressively a definite quantity of said material; and applying a magnetic field to the resulting molten mass at either side of said electrode in such a manner that the lines of flux of said magnetic field extend substantially transversely of said surfaces and intersect at right angles the lines of flow of current in said molten mass thereby to displace laterally said lines of flow of current to decrease the vertical penetration of the welding heat in said surfaces.

10. A method of producing a fillet weld at a seam formed between two metal members disposed substantially perpendicular to each other, wherein a fusible metal electrode is inserted into a body of unbonded granular welding material of high electrical resistance and having a negative temperature coefficient of resistance, said material being placed on and along the seam formed between said members, the end of said electrode being spaced from said members, such method comprising passing an electric current of sufficient magnitude through said electrode, said welding material and said members to fuse and maintain said welding material in a highly fluid state in a region forming a welding zone, said highly fluid welding material occupying the entire space forming the welding zone and constantly being in contact with said electrode and said members to supply welding heat thereto to fuse said electrode and cause such fused metal to deposit and coalesce with fused metal at the opposing edges of said metal members, feeding said electrode toward said members and moving the electrode longitudinally relatively to the seam through said body of welding material, and constantly maintaining a magnetic field adjacent to the welding zone, the lines of flux of said magnetic field intersecting the lines of flow of current in said fluid welding material and said fused metal to displace laterally said lines of flow of current thereby to increase the lateral penetration of the welding heat and provide a weld having its exposed surface terminating at and contiguous to the metal at the surfaces of said members.

11. A method of electric welding which comprises providing an unbonded granular non-metallic material of high electrical resistance and having a negative temperature coefficient of resistance in full contact with all the surfaces to be united by welding, said material containing a major portion of fused silicates and being substantially free from uncombined iron oxide and from substances capable of evolving large amounts of gases under welding conditions; inserting an electrode into said material; passing, from said electrode through said material to said surfaces, an alternating electric current of sufficient magnitude to melt progressively the portion of the electrode in said material and to heat and melt progressively a definite quantity of said material; and applying a magnetic field to such molten material in such a manner that the lines of flux of said magnetic field intersect the lines of flow of current in said molten material thereby to displace laterally alternately to one side and then to the opposite side said lines of flow of current to increase the lateral penetration of the welding heat in said surfaces and consequently to decrease the vertical penetration of the heat therein.

LLOYD T. JONES.

171 United States of America, }
Northern District of Indiana. } ss.

I, Margaret Long, Clerk of the United States District Court in and for the Northern District of Indiana do hereby certify that the annexed and foregoing is a true and full copy of the original

(1) Complaint filed 10-1-45.
(2) Separate answer of Graver Tank & Mfg. Co., Inc., filed 11-24-45.
(3) Separate answer of Lincoln Electric Company filed 11-24-45.
(4) Order adding party defendant entered 3-16-46.
(5) Amended complaint filed 3-26-46.
(6) Pretrial order entered 11-25-46.
(7) Notice pursuant to retrial order filed 12-5-46.
(8) Notice pursuant to pretrial order filed 12-6-46.
(9) Opinion of the Court entered 6-6-47.
(10) Findings of Fact and Conclusions of Law entered 6-6-47.
(11) Interlocutory Decree entered 7-9-47.
(12) Notice of appeal filed 7-9-47. (Plaintiff).
(13) Notice of appeal filed 7-9-47 (Defendants).
(14) Supersedeas bond filed 7-12-47.
(15) Stipulation for extension of time to file record of appeal and order granting same entered 8-8-47.
(16) Stipulation for extension of time to file record of appeal filed September 16, 1947.
(17) Order entered extending time for filing record on appeal, 9-17-47.
172 (18) Stipulation as to record on appeal, filed 10-6-47.
(19) Statement of points by defendants-appellants, filed 10-6-47.
(20) Statement of points by plaintiff, filed 10-6-47.

now remaining among the records of the said Court in my office.

In Testimony Whereof, I have hereunto subscribed my name and affixed the seal of the aforesaid Court at Hammond, Indiana this 6th day of October, A. D. 1947.

Margaret Long,
Clerk.

By Jean Erickson,
Deputy Clerk.

(Seal)

[fol. 988] PLACITA

At a regular term of the United States Circuit Court of Appeals for the Seventh Circuit, held in the City of Chicago, and begun on the Sixth day of October, One thousand nine hundred and forty-seven, and of our Independence the One hundred and seventy-second.

No. 9481

THE LINDE AIR PRODUCTS CO., Plaintiff-Appellant,

vs.

GROVER TANK & MFG. CO., INC., LINCOLN ELECTRIC CO. and GRAVER TANK & MFG. CORP., Defendants-Appellees

No. 9482

THE LINDE AIR PRODUCTS CO., Plaintiff-Appellee,

vs.

GRAVER TANK & MFG. CO., INC., THE LINCOLN ELECTRIC CO. and GRAVER TANK & MFG. CORP., Defendants-Appellants

Appeal from the District Court of the United States for the Northern District of Indiana, Hammond Division

[fol. 989] UNITED STATES CIRCUIT COURT OF APPEALS FOR THE SEVENTH CIRCUIT

Chicago 10, Illinois

February 13, 1948

Before Hon. William M. Sparks, Circuit Judge, Hon. J. Earl Major, Circuit Judge, Hon. Sherman Minton, Circuit Judge.

No. 9481.

THE LINDE AIR PRODUCTS Co., Plaintiff-Appellant,

vs.

GRAVER TANK & MFG. CO., INC., LINCOLN ELECTRIC Co. and GRAVER TANK & MFG. CORP., Defendants-Appellees

No. 9482

THE LINDE AIR PRODUCTS Co., Plaintiff-Appellee,

vs.

GRAVER TANK & MFG. CO., INC., THE LINCOLN ELECTRIC Co. and Graver Tank & Mfg. Corp., Defendants-Appellants

Appeal from the District Court of the United States for the Northern District of Indiana, Hammond Div.

Now this day come the parties by their counsel, and this cause comes on to be heard on the transcript of the record and the briefs of counsel, and on oral argument by Mr. John T. Cahill and Mr. Richard Wolfe for the Linde Air Products Co., and by Mr. Charles L. Byron, Mr. John F. Oberlin and Mr. James R. Stewart for the Graver Tank & Mfg. Co., Inc., et al., and the Court takes this matter under advisement.

[fol. 990] IN THE UNITED STATES CIRCUIT COURT OF APPEALS FOR THE SEVENTH CIRCUIT, OCTOBER TERM, 1947, APRIL SESSION, 1948

No. 9481

THE LINDE AIR PRODUCTS COMPANY, Plaintiff-Appellant,

vs.

GRAVER TANK & MFG. CO., INC., THE LINCOLN ELECTRIC COMPANY and Graver Tank & Mfg. Corporation, Defendants-Appellees

No. 9482

THE LINDE AIR PRODUCTS COMPANY, Plaintiff-Appellee,

vs.

GRAVER TANK & MFG. CO., INC., THE LINCOLN ELECTRIC COMPANY and Graver Tank & Mfg. Corporation, Defendants-Appellants

Appeal from the District Court of the United States for the Northern District of Indiana, Hammond Division

April 16, 1948

Before Sparks, Major and Minton, Circuit Judges

SPARKS, Circuit Judge. Plaintiff charged defendants with infringement of United States Patent No. 2,043,960 issued June 9, 1936, to Union Carbide and Carbon Corporation of New York, assignee of the inventors Lloyd Theodore Jones, Harry Edward Kennedy and Maynard Arthur Rotermund of California, who filed the patent application on October [fol. 991] 9, 1935. The patent relates both to a process or method of electric welding, and to compositions for use therein. Of the process or method claims, numbered 1 to 17 inclusive, all were in issue except claim No. 10. Of the composition claims those numbered 18, 20, 22, 23, 24, 26 and 27 were in issue.

The defenses were invalidity and non-infringement. The court held valid and infringed composition claims 18, 20, 22 and 23, and invalid, composition claims numbered 24, 26 and 27. It also held all of the process or method claims in issue invalid. From the decree plaintiff, in cause No. 9481, has appealed from the rulings adverse to it, and the defendants, in cause No. 9482, have appealed from the rulings adverse to them.

The specification states with considerable particularity the disclosures of the art at that time, as patentees then understood them. We refer in substance to the specification in order to get a fair disclosure of the problems which then confronted the applicants, and which they sought to solve. The fact that the patent was issued clothes plaintiff with the presumption of its validity.

Among the various ways in which electrical energy had been converted into heat for welding metals, the arc process was the one most generally practiced, a typical example of which is its use to join the abutting edges of steel plates. In the metal-arc variation of the arc process, molten metal, provided by the melting of a metal wire or rod of suitable composition, was introduced between the abutting edges of the plates, and the latter were fused sufficiently to permit the added metal to coalesce with the metal of the plates so that, on cooling, a structurally strong bond resulted. The requisite heat was developed by maintaining either a direct current or an alternating arc between the parts to be welded connected to one side of the power line, and the wire or rod [fol. 992] used to supply the molten metal connected to the other side of the power line. The abutting plate edges were usually beveled to form a trough for receiving the molten metal, thereby facilitating coalescence of the added metal, with the plates throughout the thiskness of the latter.

The simplicity of bare wire-electrode welding recommended it above all other methods, but the metallurgical and physical properties of metal deposited in this manner were usually so poor that the method was unsuitable for many applications.

In order to avoid certain difficulties encountered in bare metal arc welding, it was customary to protect the freshly deposited molten metal with a blanket of molten metal compounds (usually compounds of the alkali or alkaline earth metals). The material used for forming this blanket is called the "flux." The usual method of providing a flux blanket on the weld was to encase the welding rod or wire, referred to as the electrode, in an adherent sheath of solid flux, and this gave rise to other difficulties. The sheath was usually fragile and, being nonmetallic in nature, was nonconductive when cold, so that electrical connection was required to be made with the electrode at points bared for that purpose at intervals and at variable distances from the weld, thereby imposing an additional burden on the automatic regulating

devices widely used in welding. When the bared sections reached the melting zone, metal of inferior quality was deposited. The current passed through a variable length of rod, the length between the arc and the contact point, heating it sufficiently to crack off the flux covering and further to add an IR-drop to the arc voltage. This IR-drop was not constant in magnitude but varied according to the position of the contact point relative to the arc. The machine could not maintain the constant arc length so necessary to successful welding unless compensatory means were resorted to. These difficulties therefore limited the [fol. 993] energy which might be expended in the arc. The inventors were not aware of current values in excess of about 500 amperes being used in this manner of welding.

For good welding a homogeneous deposit of metal is indispensable. In metal-arc welding the difficulties in securing such deposit are multiplied as the thickness of the deposit increases, so that, in such case it becomes necessary to make several traverses or passes, adding a layer of metal each time until the necessary thickness is attained. Such method is time and labor consuming.

Another known means of applying protective flux consisted in utilizing a thick coating of finely divided material, a flux, which covered the seam to be welded. The welding electrode which is a bare wire of suitable composition was fed down by conventional feeding means and the arc was struck under the powdered flux. The electrode was traversed at a constant rate along the path to be welded. Direct current was applied at a voltage of about 30 volts with a current up to about 900 amperes. The flux used in that system was a natural clay of approximately the composition used in making brick. Although this method retained the advantage of feeding current continuously to a bare wire at a point adjacent the weld, the weld metal thus deposited thereby was deficient in quality. A weld thus made had ample strength for some purposes, but it was quite porous, was not applicable to plates over one-half inch thick, and projected a cloud of material into the atmosphere, and often required the welders to use gas masks for protection from the dust.

The objects of the present invention are said to be to avoid the disadvantageous features above referred to; to provide a process by which thick plates can be strongly and rapidly electrically welded in a single pass or in a plurality

of passes, with a weld of which the density and physical properties are at least equal to those of the parent metal; [fol. 994] to provide a process in which heavier welding currents can be used and the rate of welding accelerated; to overcome the difficulties which, in prior processes, are caused by the inherent instability of an electric arc, and its liability to be extinguished by a variety of causes; and to avoid the necessity for a flux sheath on the electrode.

It is said that the patent discloses a novel process for electric welding wherein the necessary heat is generated by the passage of a heavy electric current between a metal electrode (usually bare) and the metal plates or similar objects to be welded, the electrode being out of mechanical contact with the objects, and the current being carried across the gap between the electrode and the object by and through a conductive melt or welding composition having appropriate electrical resistance properties. The heat thus generated melts successive portions of the electrode, and the molten material is deposited as weld filler material. The welding composition serves as an active instrumentality or welding medium, inasmuch as it provides heating means, controls the rate, penetration and quality of welding, and purifies and protects the molten metal.

The specification states that the properties of a successful welding composition for this method are: (1) The chemical reaction between the components of the welding composition must be completed before it is used in welding (failure in this regard produces porosity); (2) it must be capable of controlling the penetration and the width of the weld; (3) its fluidity at welding temperatures must be such that it will not become entrained with the molten metal; (4) it must consist of chemicals which are not detrimental to the properties of the steel; and (5) it must be readily removable from the finished weld.

The composition of the welding medium is of the utmost importance. The particular composition that is to be [fol. 995] used is determined by the quality and thickness of the metal plates to be welded, by the current and voltage to be used, and by the properties it is desired to impart to the weld metal.

The inventors state in their specification that they have used calcium silicate and silicates of sodium, barium, iron, manganese, cobalt, magnesium, nickel and aluminum, both in binary and ternary combinations, in various proportions.

They state also that they have used calcium titanate and various titano-silicates, particularly when they desired to introduce titanium into the weld metal. They further state that a number of these conductive welding compositions are more or less efficacious in this process, but it is preferred to use silicates of the alkaline earth metals, such as calcium silicate, and they also prefer to add to these silicates minor proportions of alumina and of a substance adapted to lower the melting point, such as a halide salt.

The preferred composition, however, comprises, as its principal ingredients, silica, at least one basic constituent consisting of an alkaline earth such as lime or magnesia or a mixture thereof, and alumina.

The silica and basic constituent are in approximately the proportions theoretically required to form metasilicates, although a substantial excess of silica is permissible and frequently advisable. For example, if the basic constituent is lime, the proportions by weight would be approximately from 0.7 to one part of lime to one part of silica; and if magnesia is substituted for part or all of the lime, the silica is increased accordingly, so as to maintain about the same stoichiometric proportions. The alumina forms about 1% to 8% of the weight of the welding composition, and preferably about 4% to 6%. In order to cause the energy to be distributed over a larger area there is added, in various minor proportions, say 6%, a material capable of [fol. 996] reducing the energy concentration and thereby widening the weld. The preferred material for this purpose is a halide salt such as calcium fluoride.

The basic constituent preferably consists chiefly of lime and magnesia in approximately the proportions of three parts of lime to one part of magnesia, by weight, but other proportions are useful and within the invention. Basic materials other than lime or magnesia, for example oxides of manganese, titanium, or the alkali metals, and known fluxing agents such as borax or boric acid, may be added in moderate amounts without greatly changing the essential characteristics of the composition, but it is important that the composition be substantially free from iron oxides uncombined with other ingredients of the composition (by being prefused with such ingredients) and from materials (such as carbonates or moisture) which evolve detrimental amounts of gas or vapor at welding temperatures. The

material when ready for use to form the conductive melt is said to be the principal feature of the process.

The chemical condition of the welding composition is important. "The acidic and basic constituents should be reacted, the composition should be substantially anhydrous and free from gases, and all reactions which would evolve deleterious amounts of gases during welding should be substantially completed, before the medium is used in the welding process." These conditions are attained by prefusing a mixture of the constituents. Certain relatively volatile but chemicaly stable constituents, such as calcium fluoride, may be added to the medium either before or after the other ingredients have been fused and cooled. The carbonates of calcium or magnesium may be substituted for the oxides, if the ingredients are prefused.

It is also said that the physical condition of the welding composition is of the utmost importance. If the molten [fol. 997] medium is rapidly solidified by cooling before grinding and use, more homogeneous and solid welds may be produced than when it slowly loses heat and solidifies. The fused composition is preferably cast as a relatively thin layer against efficient cooling of chilling means such as a cold heavy plate or block of metal, or a water-cooled chill plate, rather than as a large ingot. It is preferred that the rate of cooling be such that substantially all of the solidified welding composition is characterized by a vitreous fracture.

In practicing the process the plates to be welded are arranged as for metal open arc welding. The edges are preferably beveled, but this is less necessary than with arc welding because the "penetration" and width of the weld is dictated by the composition of the flux and the voltage and current employed, and can be closely controlled by the process.

When a weld is to be made between beveled edges, the operation is started by filling the groove, space, or gap between the edges of the objects with the welding composition, preferably in powdered or granular form, and a substantial and additional quantity of the composition is heaped up along the groove, thereby overfilling it. After the weld is completed, that portion of the composition which has not been fused may be removed, and that portion which has been fused may be lifted from the weld. The

fused material may be reground and reused in some instances.

Pursuant to the method prescribed, the end of the welding electrode, which is preferably bare metal, is first inserted into the welding composition. Since the latter is nonconductive when cold, a conductive path for the welding current is provided by bridging the gap between the electrode and the work with a sliver of graphite or a wad of steel wool. The power is then applied, the welding com- [fol. 998] position is locally heated until it fuses and becomes conductive, forming a subsurface pool, and immediately thereafter the end of the electrode begins to fuse and the molten metal begins to deposit in the groove, displacing the subsurface pool of fused welding composition. At the same time, the edges of the object being welded begin to fuse and to coalesce with the deposited metal. The electrode is then fed toward the work and moved along the seam at an appropriate rate preferably by a mechanical device which may be similar to those which are extensively used in open arc welding, and the welding proceeds without interruption under a protective layer of the composition. There is practically no puffing or visible displacement of the welding medium, no visible sparking and scarcely any external evidence that the weld is being made. The weld is ordinarily completed in one pass, even in thick plate. The welding composition in front of the electrode remains unfused, while the fused composition rises to the top of the completed portion of the weld and solidifies. This effect is scarcely visible because of the use of an excess of the welding composition which remains unfused and covers the fused composition and metal.

Either alternating or direct current, or direct current superimposed on alternating current may be used, but alternating current is preferred.

The application states that the process here employed does not depend on the formation of an arc of the usual type:

> "* * * If, while a weld is being made, the circuit is opened externally of the weld and then closed again while the resistive composition is still molten, the current will immediately resume its flow without any necessity for moving the electrode into contact with the seam as it would be necessary to do to reestablish an

arc of the usual type. The heat for melting the electrode is evidently developed in the conductive melt [fol. 999] itself.

"The conductive welding composition used in our process doubtless performs the protective functions of a flux, but it is much more than a flux, and many compositions which are satisfactory fluxes for arc welding are unsuitable for our purpose. * * *"

The District Court said, and we think rightly, that Jones, Kennedy and Rotermund invented something patentable over the prior art of electric welding. He thought their method of welding differed vastly from electric-arc hand welding, either of the bare or coated rod variety, and that there was "an inventive level-difference" between their method and Robinoff's automatic welding method. He calls attention to the differences in the physical appearances in the welding zones of the patent, and those of any of the prior art during their operations. "In bare rod and coated rod hand welding, the electric arc creates a blinding glare and there is a great amount of smoke and splatter. In the Robinoff clay flux method constant flashings occur, and the arc is always at least partially visible." In those of the patent "there is no glare, no open arc, no splatter, and very little, if any smoke, * * *. The truly remarkable difference, however, between what Jones, Kennedy and Rotermund invented and what had gone before is perhaps best manifested by the performance achievements of their invention. For instance, only through its use can plates as thick as two and one-half inches be welded in a single pass. Furthermore, the welding speeds made possible by it dwarf those of any other method, and the welds produced by it are of the highest quality in contrast to the great amount of porosity contained in the welds produced by the so-called clay flux process."

Having thus determined that there was patentable invention, the court then proceeded to determine what was patentable, whether process or composition or both. As to the method he posed the question "whether a fundamental dif- [fol. 1000] ference in phenomena exists between the Jones, et al. method and all methods of electric arc welding. If it could be said without equivocation that the electric current passing between the electrode and the base metal travels through a welding composition which is in a melted or liquid state

and that no 'electric arc' is present, then a different electrical phenomenon would exist and a radically new process in electric welding would have been discovered. But no such finding can be made. The evidence is persuasive that no such basic difference in phenomena is present in the Jones, et al. method."

We construe this statement to mean that the court thought the invention as to method, would have been patentable if it had disclosed that there was no arc present, and that the electrical current passing between the electrode and the base metal traveled through the welding composition, *only* when such composition was in a melted or liquid state.

With respect to this point, the court in substance said that in the inventors' experiments it was hoped by them to give a better weld than was being obtained by the Robinoff process, which involved an electric arc phenomenon. During the course of their experiments, they evolved a composition which produced better welds. However, he said in substance that the purely operational use of their welding composition was the same as the clay flux in the Robinoff process, and there was and is no difference between the Robinoff and Jones and other methods. In both methods a deep layer of flux or welding composition is laid in the V formed by the beveled edges of the plates to be welded; a bare welding rod is fed down through this composition; and an electric current which produces the heat to weld the plates is conducted from the rod to the base metal. Thus, the court said, the physical operational steps in the two methods are identical.

[fol. 1001] Plaintiff's appeal is taken from so much of the decree as held invalid claims 1 through 9, and 11 through 17, and claims 24, 26 and 27. The court considered these claims in four groups, and as a matter of convenience we shall do likewise.

Claims 1, 3, 4, 7, 8 and 9 were held to be invalid because they were too broad and indefinite to satisfy the statute, that is to say, because they were said to make no reference to the chemical constituents of the welding composition. These were not claims to a composition of matter or chemical compound but they were all process or method claims as expressed in finding number 7:

> "Their invention also included a novel welding process in the sense that the electric arc present between the

> electrode and base metal is sheathed by a mantle of molten welding composition and in that the conductive arc area is composed predominantly of vaporous welding composition."

There the court correctly described the alleged novel process without in any way referring to any chemical composition.

We think it was unnecessary in a process claim to refer in any way to the chemical constituents of the composition where, as here, they are fully set forth in the specification. We think this view is fully supported in principle by the Telephone Cases, 126 U. S. 1; Union Oil Co. of California v. American Bitumuls Co., 109 F. 2d 140; Van der Grinten v. Dieterich-Post Co., 85 F. 2d 637; and Glade v. Walgreen Co., 122 F. 2d 306.

Furthermore, these claims now under consideration seem to be sufficiently definite when construed in the light of the specification. The statute merely states that the claims should particularly point out and distinctly claim the part, improvement, or combination which the applicant claims is his invention or discovery. 35 U.S.C.A., section 33. It would seem that this statute only requires that the claims [fol.1002] point out the invention, not that they redescribe it.

The court's reason for holding invalid process claims 5 and 6, and 11 through 17, is set forth.

> "* * * The import of each of these claims is that the *sole conductive medium* through which the electric current passes from the electrode to the base metal is the welding composition which is in a *molten* state and that the electric arc phenomenon is not present. * * * While a patent covering a meritorious invention should not be struck down because the patentee has misconceived the scientific principle of his invention, the error cannot be overlooked when the misconception is embodied in the claim." (Our emphasis.)

Claim 6 is typical.[1]

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[1] "The process of electric welding which comprises the steps of juxtaposing a metal electrode and a conductive member on which metal is to be deposited; establishing be-

None of these nine claims refer in any manner to the presence or absence of an arc, either directly or by reasonable inference. The reason is that the applicants did not know, and they carefully avoided any commitment on that subject. There was no visible evidence of its presence, and for that reason it was impossible for them to determine that [fol. 1083] scientific fact, nor was it incumbent upon them to do so. The file wrapper discloses that the applicants said to the Examiner:

> "It is difficult, if not impossible, to define an arc precisely, and applicants have contemplated the possibility that a definition may be framed in such terms as to embrace the phenomenon which occurs in their process.
>
> "There can be no question, however, that there is no such arc involved in their process as occurs in every prior art process including that of Robinoff, et al."

We are convinced that the District Court also erred in its statement, which we have quoted, to the effect that the import of these claims is that the *sole conductive medium* through which the electric current passes to the base metal is the welding composition which is in a *molten* state. This no doubt occurred through its interpretation of the phrase "conductive melt," coined by the inventors to identify their welding compositions. This interpretation, if correct, would preclude the existence of such compositions in vaporous form. It is clear that in this respect the court should adopt the same interpretation of the term "conductive melt" which the applicants reasonably expected it to have when they coined it. It is clear to us from its context in the patent, and the circumstances of its origin clearly indicate

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tween said member and said electrode a conductive melt comprising an alkaline earth metal silicate, alumina, and an alkaline earth metal fluoride, substantially free from substances, such as uncombined iron oxide, capable of evolving gases when fused in contact with the metal to be welded; passing through said melt an electric current of sufficient magnitude to maintain the conductivity, progressively melt the said electrode and cause the resulting molten metal to coalesce with said member; and maintaining said melt in contact with said electrode and member throughout the welding operation."

that the applicants intended the phrase to mean, when heated to welding temperatures, in either liquid or vaporous state.

This construction is quite consistent with the views expressed by experts of both plaintiff and defendants; with the Welding Handbook of the American Welding Society, and with Webster's New International Dictionary since 1936, which defines "fluid" to mean "liquid or gaseous." The specification expressly states "that the relatively high current densities which are preferably used superheat the [fol. 1004] molten metal and welding composition, making them highly fluid."

The District Court held composition claim 27 invalid because it contained the words "a prefused electric welding composition which is conductive when molten * * *." The court, as before, thought that these words gave the inevitable impression that the electric current passes through the composition only while it is in a molten state. From what we have just said with respect to the last method claims, we think the holding was erroneous, and the same may be said with respect to process claim 1.

The District Court held process claim 2 and composition claims 24 and 26 invalid on the ground that a number of silicates had been shown to be inoperative. The composition is described as a silicate in process claim 2, as a metallic silicate and calcium fluoride in composition claim 24, and as consisting chiefly of silicates in composition claim 26. It rejected plaintiff's contention that "silicates" and "metallic silicates," when read in the light of the specifications, meant the nine metallic silicates which had been proved operative. The court based its ruling upon Aluminum Company of America v. Thompson Products, Inc., 122 F. 2d 796. We fully agree with what is there said. However, there is nothing in this record to support the fact that the applicants for this patent intended by these claims to assert any monopoly broader than nine metallic silicates named in the specifications. Under these circumstances, we think the court should have applied the general rule as laid down in the case just referred to and followed the construction which would sustain them.

It is only when these claims last referred to are read alone, without regard to the rest of the patent, that the terms "silicates" and "metallic silicates" can be construed as mean-

ing all "silicates" or all "metallic silicates." It seems clear to us that when the patent is read as a whole it is quite plain [fol. 1005] that these terms refer to the three outlined earth silicates plus the six other metallic silicates listed in the specifications as their equivalents. We think the court should have held valid the process claim 2 and composition claims 24, 26 and 27.

The only issues involved in defendants' appeal are the validity and infringement of composition claims 18, 20, 22 and 23. The latter is typical.[2]

Plaintiff's process was quite different from that of the prior art disclosures in that the latter depended on the evolution of more gas to protect the molten metal, while plaintiff's proceeds on the theory of eliminating all gas forming ingredients. That difference is clearly one of process. True, plaintiff's process contemplated and depended upon a different composition of flux, and the patent was issued on both process and flux composition, and we think rightly so. There are as many different kinds of flux as there are elements and combinations of elements, and when thus used their results are quite as numerous. However, this patent was not granted upon a result, but it was granted upon a process or method which produced a much desired result, and which was then unknown to the art. Any other process or method which produces the same result would not infringe this process patent, provided it does not use this method or its equivalent, and this would be true regardless of what flux, if any, was used for such purpose.

The court found that the patent included a novel welding process in the sense that the electric arc between the elec- [fol. 1006] trode and base metal is sheathed by a mantle of welding composition and that the conductive arc area is composed predominantly of vaporous welding composition; that the capabilities of the invention represented an important advance in the welding art; that compositions

[2] Claim 23. "A finely divided unbonded fusible composition for use in electric welding employing a bare metal electrode as a source of weld metal, said composition being substantially free from substances capable of evolving a detrimental quantity of gas under welding conditions and containing calcium fluoride and a major proportion of one or more alkaline earth metal silicates."

of calcium, magnesium, strontium and barium, when prepared in accordance with the specification, are operative as welding compositions within the teachings of the patent; that these elements are known in chemical literature as alkaline earth metals; that manganese is not an alkaline earth metal; that manganese silicate is one of the nine metallic silicates which the specification discloses that the inventors have used as principal constituents in welding compositions attaining more or less effectively the objectives of their invention; that manganese silicate when used as a principal constituent of a welding composition, prepared according to the teachings of the patent, is a proper substitute for the silicates of the alkaline earth metals.

The court further found that the defendants used and sold their accused composition since 1942, and are still using it, and it is substantially identical in operation and result with that of the patent; and that such flux is a calcium manganese aluminum silicate, with calcium fluoride added, which in welding operation is in all respects equivalent to the compositions of the patent; that a person skilled in the art can produce the accused flux of the defendants by following the teaching of the patent in suit; that no evidence was introduced to show that the accused flux was derived from the prior art or by independent experiment, or from any source other than the teaching of the patent in suit. It was further found that in the defendants' flux the slight excess of basic oxide over stoichiometric proportions does not substantially affect its operative character and it follows the teaching of the patent; that the patent [fol. 1007] teaches the substitution of manganese for other basic oxides and is not limited to the use of a moderate amount of manganese in addition to other basic oxides.

The court further found that plaintiff does not, as alleged by the defendants, impose as a condition of the license under the patent in suit, nor does it ever impose on its licensees any requirement, condition, agreement or understanding as to the purchase or use of merchandise, machinery or supplies or other commodities; and the licensees are free to buy and use any materials and equipment from any source. These questions of fact are supported by substantial evidence and we may not disturb them.

We find no error in the court's ruling on the issues raised by the cross-appeal. We affirm so much of the District

Court's decree as holds valid and infringed claims 18, 20, 22 and 23. We reverse that part of his decree which holds invalid all of the process or method claims in issue, and composition claims 24, 26 and 27. The cause is ordered remanded to the District Court for further proceedings not inconsistent with this opinion.

A true Copy: Teste:

——— ———, Clerk of the United States Circuit Court of Appeals for the Seventh Circuit.

[fol. 1008] UNITED STATES CIRCUIT COURT OF APPEALS FOR THE SEVENTH CIRCUIT, APRIL 16, 1948

Before Hon. William M. Sparks, Circuit Judge; Hon. J. Earl Major, Circuit Judge; Hon. Sherman Minton, Circuit Judge

No. 9481

THE LINDE AIR PRODUCTS COMPANY, Plaintiff-Appellant,

vs.

GRAVER TANK & MFG. CO., INC., THE LINCOLN ELECTRIC CO., and Graver Tank & Mfg. Corporation, Defendants-Appellees

Appeal from the District Court of the United States for the Northern District of Indiana, Hammond Division

This cause came on to be heard on the transcript of the record from the District Court of the United States for the Northern District of Indiana, Hammond Division, and was argued by counsel.

On consideration whereof, it is ordered, adjudged and decreed by this Court that the decree of the said District Court in this cause appealed from be, and the same is hereby, Affirmed insofar as it holds valid and infringed claims 18, 20, 22, and 23; and that that part of the said decree which holds invalid all of the process or method claims in issue, and composition claims 24, 26 and 27, be, and the same is hereby, Reversed.

It is further ordered that this cause be, and the same is hereby, remanded to the said District Court for further pro-

ceedings not inconsistant with the opinion of this Court filed this day.

It is further ordered that the costs of this appeal be taxed in favor of the plaintiff-appellant, The Linde Air Products Company.

[fol. 1009] United States Circuit Court of Appeals for the Seventh Circuit, April 16, 1948

Before Hon. William M. Sparks, Circuit Judge; Hon. J. Earl Major, Circuit Judge; Hon. Sherman Minton, Circuit Judge

No. 9482

The Linde Air Products Company, Plaintiff-Appellee,

vs.

Graver Tank & Mfg. Co., Inc., The Lincoln Electric Co., and Graver Tank & Mfg. Corporation, Defendants-Appellants

Appeal from the District Court of the United States for the Northern District of Indiana, Hammond Division

This cause came on to be heard on the transcript of the record from the District Court of the United States for the Northern District of Indiana, Hammond Division, and was argued by counsel.

On consideration whereof, it is ordered, adjudged and decreed by this Court that the decree of the said District Court in this cause appealed from be, and the same is hereby, Affirmed, with costs.

In the

United States Circuit Court of Appeals

FOR THE SEVENTH CIRCUIT

THE LINDE AIR PRODUCTS COMPANY,
Plaintiff-Appellant,

vs.

GRAVER TANK & MFG. CO., INC., THE LINCOLN ELECTRIC COMPANY and GRAVER TANK & MFG. CORPORATION,
Defendants-Appellees.

No. 9481.

THE LINDE AIR PRODUCTS COMPANY,
Plaintiff-Appellee,

vs.

GRAVER TANK & MFG. CO., INC., THE LINCOLN ELECTRIC COMPANY and GRAVER TANK & MFG. CORPORATION,
Defendants-Appellants.

No. 9482

APPEALS FROM THE DISTRICT COURT OF THE UNITED STATES FOR THE NORTHERN DISTRICT OF INDIANA, HAMMOND DIVISION.

PETITION FOR REHEARING

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In the

United States Circuit Court of Appeals

FOR THE SEVENTH CIRCUIT

THE LINDE AIR PRODUCTS COMPANY,
Plaintiff-Appellant,

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PETITION FOR REHEARING

Now come Graver Tank & Mfg. Co. Inc., The Lincoln Electric Company, and Graver Tank & Mfg. Corporation, and file this their petition for a rehearing of the above causes, and in support thereof respectfully represent:

I. The Court, by sustaining as valid the process claims of the Jones *et al.* patent in suit, has revived and handed over to plaintiff the prior and now expired Robinoff Patent No. 1,782,316.

II. The Court, by sustaining as valid and infringed the composition claims of the patent in suit, has revived and handed over to plaintiff the prior and now expired Miller Patent No. 1,734,566.

III. As interpreted by this Court, the process of the patent in suit covers merely a result which by well established authority cannot be patented.

IV. By treating conclusions of law as if they were findings of fact and upholding them merely upon the basis that there is something in the record to support them, while at the same time completely disregarding true findings of fact by the District Court, this Court has departed from the accepted and usual course of judicial proceedings.

V. In adopting the District Court's finding that plaintiff does not impose as a condition of the license under the patent in suit, nor does it ever impose on its licensees requirements which constitute a misuse of said patent, this Court has ignored the legal effect of the admitted facts as to plaintiff's conduct.

These consequences the Court obviously can not have intended. Such, however, is the result of the decision as next will be demonstrated.

I. The Court, by sustaining as valid the process claims of the Jones et al. patent in suit, has revived and handed over to plaintiff the prior and now expired Robinoff Patent No. 1,782,316.

The Court has, in effect, revived the Robinoff patent No. 1,782,316 (Deft. Exh. 103, R. 974), which expired November 18, 1947, and has given it as revived to plaintiff. This is the result even though the Robinoff process is used with the so-called clay flux (principally aluminum silicate) commercially used by Robinoff, or for that matter, with any flux whatever.

The District Court, in formal finding of fact, described the Robinoff process as follows (Finding 26, R. 927):

"26. Prior automatic electric welding processes and particularly in the Robinoff Process as commercially practiced by National Tube Co., at McKeesport, Pa., and by Western Pipe & Steel Co., at San Francisco, Calif., the following procedural steps have been employed:

(a) The plates to be welded are arranged with abutting edges which are beveled so as to form a V-shaped groove.

(b) Means for backing up the seam during welding are provided.

(c) The groove thus formed is filled with a welding composition in powdered or granular form.

(d) A mechanical device in the form of a welding head is mounted so as to be movable along the seam, such head including an automatic electrode feeding device whereby the electrode in the form of a rod or wire is drawn from a reel and fed toward the plates or work-pieces as the head moves thus along the seam.

(e) The welding operation is initiated by inserting the end of such electrode or wire into the welding composition, striking the arc, and then applying the power."

The District Court also found as a fact that all the operational steps in the Robinoff patent are identical, as they admittedly are, with the operational steps in the Jones patent (Finding 27, R. 927):

"27. The procedural steps followed in the welding process taught by the patent are identical in all respects with those followed in prior automatic electric welding processes, and particularly in such Robinoff process, and *the only novelty presented by the process of the patent resides in the use of a different welding composition in the carrying out of such procedural steps.*" (Emphasis added.)

Neither of these findings has been questioned by this Court. On the record, neither could be.

And yet, the process claims of the Jones *et al.* patent are held valid, "without in any way referring to any chemical composition" (Op. 12).

No reason is given why Robinoff did not anticipate the Jones *et al.* process. True, reference is made, as found by the District Court, to the occurrence of flashings in the Robinoff process and that the arc is always at least partially visible, while in the main, the reverse is true in Jones *et al.* This, however, is but a difference in appearance and does not involve a difference in process. For that matter this difference in appearance is illusory. In the only demonstration of defendants' Lincolnweld process in actual commercial use at the Graver plant, the very same phenomena occurred, which are now used to characterize Robinoff. See the movie and still photos, Pltf. Exhs. 187-A, 187-B and 188 and the Quigley deposition (R. 558); also defendants' demonstration during the trial (R. 636).

The statement is also made by the Court (Op. 16) that plaintiff's process differs from that of the prior art in that "the latter depended on the evolution of more gas to protect the molten metal, while plaintiff's proceeds on the theory of eliminating all gas forming ingredients." In no event would this import a difference in process, as this Court has said. At the most such difference could only be attributed to a difference in composition. Moreover, the quoted statement clearly ignores the disclosure in the prior art of welding compositions or fluxes which were prefused in exactly the same manner as taught in the patent in suit and for identically the same purpose. Thus, in Miller Patent No. 1,741,031 (Defs. Ex. 145, p. 1, col. 1) it is expressly set forth:

> "The flux should be substantially non-volatile at the welding temperature and furthermore should not evolve such quantities of gases, as by decomposition of its con-

stituents or reaction among them, that the flux puffs or froths away from the surface of the molten metal."

One is driven inevitably to the conclusion that Robinoff and Jones *et al.* are identical so far as process is concerned. As found by the District Court they can differ only in that the latter used a different flux. Nevertheless this Court disclaims any intention to treat the flux and its chemical properties as part of the process.

The expired Robinoff patent is therefore given a new lease on life. Even the claims of the patent in suit are read as coextensive with those of Robinoff, e.g., Robinoff's claim 8:

> "In a method of seam welding, the steps of first forming a groove along the seam to be welded, then depositing a body of flux in said groove, and then moving a metal electrode along said groove and drawing an arc causing said flux to melt and melting said electrode so as to deposit the molten metal from said electrode through said melted flux."

But what of defendants? Defendant Lincoln has been operating under a license under Robinoff. So did plaintiff, in recognition of the fact that it was practicing Robinoff's process. Lincoln had the right to practice the Robinoff process. Now, all the world has that right, since the patent has expired.

As was pointed out in *American Fruit Growers, Incorporated v. Brogdex Co.*, 283 U. S. 1, 14, 75 L. Ed. 801, 808:

> "If the claims of the patent in suit are valid, one operating under the process described by Bishop would infringe—and considering the circumstances here disclosed, that is enough to show invalidity of the later patent. *Knapp v. Morss*, 150 U. S. 221, 228, [37 L. Ed. 1059, 1062, 14 S. Ct. 81]."

Under this Court's decision carried to its logical conclusion, defendants cannot even use Robinoff's old equip-

ment with Robinoff's old flux. The District Court, affirmed by this Court, found that manganese is not an alkaline earth metal but is, in patent law, the equivalent. This is because it works successfully, which we submit is no reason at all, and because the specification of the patent says that the inventors have used "calcium silicate and silicates of sodium, barium iron manganese, cobalt magnesium, nickel and aluminum, both in binary and ternary combinations, in various proportions." Thus it is reasoned that the inventors labeled manganese as a substitute, but if they did, they also labeled aluminum as a substitute. The result is that Robinoff's clay flux, because it is mainly an aluminum silicate, likewise infringes. So the world now owns Robinoff, but to no avail.

Manifestly, this Court will not wish to let stand a decision the effect of which is, or may be, to put in jeopardy the entire industrial world, not only in the electric welding field, but in all other fields to which similar principles of patent interpretation may be applied. The possibility of such result is alone enough to call for the exercise by this Court of its power to rehear.

II. The Court, by sustaining as valid and infringed the composition claims of the patent in suit, has revived and handed over to plaintiff the prior Miller patent No. 1,754,566 (Deft. Exh. 145, R. 969) which expired April 15, 1947.

This Miller patent explicitly teaches *and claims* (p. 3, ll. 33 *et seq.*, R. 971) *a process of welding ferrous metals* using either *the arc process* or the blow pipe process,

> "*which comprises fusing the metal and depositing the same under a molten slag containing manganese silicate.*" (Emphasis added.)

It further teaches that such manganese silicate welding composition or flux *may be utilized* either as a coating on

the welding rods or electrodes or *in the form of a powder into which the electrode may be dipped* (Id. ll. 17 *et seq.*).

The disclosure of this Miller patent relative to the use of manganese silicate as a welding composition or flux is so much more explicit than that found in the patent here in suit that it is incomprehensible that this Court should fail to make note thereof and at the same time ignore the effect of the well-established principle of patent law that that which infringes if later anticipates if earlier. *Knapp v. Morss,* 150 U. S. 221, 228, 37 L. Ed. 1059, 14 S. Ct. 81.

In the latest patent case decided by the Supreme Court, *Funk Brothers Seed Co. v. Kalo Inoculant Co.,* 333 U. S. 127, Mr. Justice Frankfurter, in a concurring opinion holding invalid patent claims to an inoculant comprising a plurality of selective mutually non-inhibitive strains of different species of bacteria, stated (333 U. S. at p. 134):

> "The Circuit Court of Appeals seems to me to have proceeded on the assumption that only 'a particular composite culture' was devised and patented by Bond, and then applies it to 'any composite culture' arrived at by deletion of mutually inhibiting strains, but strains which may be quite different from Bond's composite culture.
>
> "The consequences of such a conclusion call for its rejection. Its acceptance would require, for instance in the field of alloys, that if one discovered a particular mixture of metals, which when alloyed had some particular desirable properties, he could patent not merely this particular mixture but the idea of alloying metals for this purpose, and thus exclude everyone else from contriving some other combination of metals which, when alloyed, had the same desirable properties."

The foregoing is substantially what this Court said about another composition in *Darwin & Milner Inc. v. Kinite Corp., et al.,* 72 F. (2) 437, and is believed to be directly applicable to all of the composition claims of the patent here in suit. Acceptance of the interpretation of

said claims, as found in the opinion of this Court, would exclude everyone else from contriving some other combination of ingredients which would have the same desirable properties.

Indisputably the welding composition taught by the patent in suit is one containing a major proportion of an alkaline earth metal silicate, specifically calcium silicate. Moreover, irrespective of any language in the specification of said patent, how can manganese silicate become the equivalent of such alkaline earth metal silicate in view of the Miller patent disclosure? The result of this Court's holding is to condemn anyone using the Miller composition as an infringer of the Jones *et al.* patent.

That which has occurred can be very simply stated. Plaintiff has secured a patent on a flux containing a major proportion of an alkaline earth metal. Manganese astonishingly becomes its equivalent. The Miller invention of a manganese flux has now reached the stage where it has become public property, but if the public practices it it flies in the face of Jones *et al.* and is to be sued by Linde. The Miller patent is disposed of by the simplest of expedients. It is not even mentioned.

III. As interpreted by this Court, the process claims of the patent in suit cover merely a result, which by well established authority cannot be patented.

While in its opinion (p. 16), the Court recognizes that

> "plaintiff's process contemplated and depended upon a different composition of flux,"

nevertheless, as more fully set forth in following Section IV of this petition, this Court has entirely ignored the District Court's findings to the effect that

> "The *only novelty* presented by the process of the patent resides in the use of a different welding composition * * *." (Emphasis ours.)

Likewise, while in its opinion this Court states (Id.) "this patent was not granted upon a result," clearly the effect of the Court's opinion is to grant plaintiff a patent on the result of using the old procedural steps of Robinoff, with any composition whatever, provided that the result is

> "that the electric arc between the electrode and base metal is sheathed by a mantle of welding composition and that the conductive arc area is composed predominantly of vaporous welding composition." (Op. 16-17.)

Thus interpreted the process claims of the patent in suit obviously distinguish, and can distinguish, from the prior art only by such result, without the slightest indication as to how it is obtained, since ignoring the District Court's findings, this Court has held that (Op. 12)

> "it was unnecessary in a process claim to refer in any way to the chemical constituents of the composition where as here they are fully set forth in the specification."

The only suggestion of a criterion is that *as a result* of the operation, by whatever means such result is accomplished, the arc is sheathed by a mantle of molten welding composition (whatever the composition). As well stated by Mr. Chief Justice Taney in *O'Reilly et al. v. Morse et al.*, 15 Howard 62, 112, 14 L. Ed. 601, 623:

> "It is impossible to misunderstand the extent of this claim. He claims the exclusive right to every improvement where the motor power is the electric or galvanic current, and the result is the marking or printing intelligible characters, signs, or letters at a distance."

As further stated in the cited opinion:

> "New discoveries in physical science may enable him to combine it with new agents and new elements, and by that means attain the object in a manner superior to the present process and altogether different from it. And if he can secure the exclusive use by his present patent he may vary it with every new dis-

covery and development of the science, and need place no description of the new manner, process, or machinery, upon the records of the patent office. And when his patent expires, the public must apply to him to learn what it is. * * * The court is of opinion that the claim is too broad, and not warranted by law."

So here, new discoveries in physical (or chemical) science may enable a worker in the electric welding field to combine new agents and elements which will attain a result the same or superior to that obtained by the process described in the patent in suit, only to be barred by the decision here in question.

In the case of *Halliburton Oil Well Cementing Co. v. Walker*, 329 U. S. 1, 91 L. Ed. (Adv.) 15, Mr. Justice Black commented on a patent claim drawn to a combination of elements whereby a desired result was obtained as follows:

"Under these circumstances the broadness, ambiguity, and overhanging threat of the functional claim of Walker become apparent. What he claimed in the court below and what he claims here is that his patent bars anyone from using in an oil well any device heretofore or hereafter invented which combined with the Lehr and Wyatt machine performs the function of clearly and distinctly catching and recording echoes from tubing joints with regularity. Just how many different devices there are of various kinds and characters which would serve to emphasize these echoes, we do not know. The Halliburton device, alleged to infringe, employs an electric filter for this purpose. In this age of technological development there may be many other devices beyond our present information or indeed our imagination which will perform that function and yet fit these claims. And unless frightened from the course of experimentation by broad functional claims like these, inventive genius may evolve many more devices to accomplish the same purpose. See *United Carbon Co. v. Binney & Smith Co.*, 317 U. S. 228, 236 [87 L. Ed. 232, 237, 63 S. Ct. 165]; *Burr v. Duryee*, 1 Wall [(U. S.)] 531, 568 [17 L.

Ed. 650, 657]; *O'Reilly v. Morse*, 15 How. [(U. S.)] 62, 112-13 [14 L. Ed. 601, 623, 624]. Yet if Walker's blanket claims be valid, no device to clarify echo waves, now known or hereafter invented, whether the device be an actual equivalent of Walker's ingredient or not, could be used in a combination such as this, during the life of Walker's patent."

So here, if the process claims of the patent in suit are valid for the reason given in the opinion, no welding composition now known or hereafter invented, whether such composition be an actual equivalent of the Jones *et al.* composition or not, could be used in a process such as this during the life of that patent.

Furthermore, the result in question is nowhere described in the specification of the patent in suit. On the contrary, as recognized and set forth in the Opinion of the District Court, the patent specification teaches an entirely different and indeed a false result, on which all of the process claims in suit, as well as composition claim 27, are dependent. Thus in said opinion (R. 911) said court explicitly stated, in effect, as a finding of fact,

> "The plaintiff contends that the submergence of the tip of the welding rod in the pool of fused flux is the key feature of the invention; or as stated in the argument, the unique feature is the contact of the welding rod with the fused pool of flux. *If by this contention is meant that between the end of the welding rod and the vaporous arc zone there is an area of fused flux, it is not sustained by the evidence.*" (Emphasis added.)

Accordingly the District Court upon taking up the process claims in suit correctly held (R. 915):

> "The import of each of these claims is that the sole conductive medium through which the electric current passes from the electrode to the base metal is the welding composition which is in a molten state and that the electric arc phenomenon is not present. To make a claim for a welding process in which these erroneous ideas are incorporated is to stake out a process or

means of welding which does not in point of fact exist within the invention.

"While a patent covering a meritorious invention should not be struck down because the patentee has misconceived the scientific principle of his invention, the error cannot be overlooked when the misconception is embodied in the claim."

IV. By treating conclusions of law as if they were findings of fact and upholding them upon the basis that there is something in the record to support them, while at the same time completely disregarding true findings of fact by the District Court, this Court has departed from the accepted and usual course of judicial proceedings.

While it is recognized that the Jones *et al.* patent contains process claims and composition claims, this Court itself puts to one side the composition claims insofar as concerns its holding that the process claims are valid.

Thus the process phase of the case is reduced to a comparison of operational steps as between Jones *et al.* and Robinoff. The District Court made proper findings upon this subject. We have already set forth finding 26 describing the Robinoff process with admitted accuracy, and finding 27 pointing out its identity with the Jones *et al.* process. These are true findings of fact. This Court, however, while nowhere questioning these findings directly, completely overthrows them in effect by its judgment. If there be a place in this case, where the Court should have applied the entrenched rule that findings of fact, if supported by substantial evidence, are to be followed, this is that place.

Again, in finding number 15, the District Court said "the composition of the welding medium is the essential feature of the invention." This Court, by its upholding of the process claims, as to which the trial court expressly found no invention, completely overrides the trial court's true finding of fact.

The Court has similarly misconstrued the effect of the District Court's finding number 7 by ignoring the first sentence of said finding, to-wit:

"Jones *et al.* invented an improved welding composition usable in the operational method of welding taught by Robinoff."

and by overlooking the effect of related finding number 15, viz.:

"The composition of the welding medium is the essential feature of the invention."

In sharp contrast with this treatment of true findings of facts, this Court treats, as if they were findings of facts, the following "findings of the District Court which actually were conclusions of law based on a misinterpretation of the specification of the patent in suit, viz.:

"14. The patent discloses that manganese silicate, when used as a principal constituent of a welding composition prepared according to the teaching of the patent is a proper substitute for the silicates of the alkaline earth metals" (R. 925).

"24. The patent in suit teaches the substitution of manganese for other basic oxides and is not limited to the use of a moderate amount of manganese in addition to other basic oxides" (R. 927).

That the foregoing are not true "findings" but *only conclusions*, is confirmed by what the District Court expressly stated in his opinion (R. 920):

"*no determination need be made whether it is a known fact outside the teachings of the patent that manganese is an equivalent of calcium or magnesium*" (Emphasis ours).

It is clear therefore that the District Court's findings 13, 14, 22, 23 and 24 merely represent his interpretation of the patent specification.

In any event, the foregoing "findings" are improperly so designated for inasmuch as letters patent are contracts,

questions of construction thereof are questions of law for the judge, not questions of fact for the jury. See *Walker on Patents*, Deller Ed., Vol. 2, p. 1209, and numerous cases there cited. It is therefore clearly the duty of this Court to examine the specification of the patent in suit as specificially requested by defendants' Statement of Points 4(c) and (d), R. 939, particularly since the plain reading of the language of the patent specification (p. 2, col. 1, ll. 62 to 75 inc. and col. 2, ll. 29 to 42 inc., R. 956) contradicts the conclusions of the District Court which this Court has apparently accepted as findings of fact "supported by substantial evidence" and therefore not to be disturbed.

It is entirely manifest that defendants have not received the sort of judicial consideration of these interpretations of the patent which the law assures it. This Court says, presumably in relation to the entire discussion of findings beginning at the bottom of page 16 of its opinion:

> "These questions of fact are supported by substantial evidence and we may not disturb them."

At the very least, it may be said that at least up to this moment the approach of this Court to pure questions of law is a legally insufficient one. True, all that defendants are entitled to demand is that the Court give its unfettered judicial consideration to these legal questions, without indulging in presumptions which would arise only if they were fact determinations, but defendants can get that consideration to which they are entitled only if this Court accords a rehearing and a re-argument.

V. In adopting the District Court's finding that plaintiff does not impose as a condition of the license under the patent in suit, nor does it ever impose on its licensees requirements which constitute a misuse of said patent, this Court has ignored the legal effect of the admitted facts as to plaintiff's conduct.

The acts of the plaintiff here charged to constitute a violation of the law, and specifically of Sec. 3 of the Clayton Act, U. S. C. Sec. 14, are unequivocally established by the record. See par. 13 of Pre-Trial Order, R. 19, 20.

Accordingly the only question presented is a question of law, i.e. the interpretation of the legal effect of plaintiff's acts as to whether they constitute misuse of the patent in suit. Here again, this Court has treated the conclusion of the District Court that no such misuse has occurred as though such conclusion were a finding of fact.

If plaintiff's rod purchase agreements were directly incorporated with the license agreements in a single contract, there would be no question about the illegal effect of such contract.

The District Court in the pretrial order found as follows:

> "(b) In about ten percent. (10%) of the cases where licensees of plaintiff under the several forms of license agreements, Defendants' Exhibits 29 to 33, inc. and 77-A to -R, inc., have also entered into one of the aforesaid Rod Contracts, the date of execution of the license agreement and the Rod Contract is the same, although in some cases the actual execution may not have occurred simultaneously, and such execution may have been by different individuals acting on behalf of plaintiff and the licensee and purchaser.
>
> (c) Some of the Rod Contracts having the same date of execution as corresponding license agreements are still outstanding and in effect as of this date." (R. 20.)

These facts alone clearly indicate a misuse of the patent which prevents plaintiff successfully obtaining equitable relief.

Carbice Corporation of America v. American Patents Development Corporation, 283 U. S. 27, 33; 51 S. Ct. 334: 75 L. Ed. 819;

Leitch Manufacturing Co. v. Barber Company, 302 U. S. 458; 58 S. Ct. 288; 82 L. Ed. 371;

Morton Salt Co. v. G. S. Suppiger Co., 314 U. S. 488; 62 S. Ct. 402; 86 L. Ed. 363;

B. B. Chemical Co. v. Ellis, 314 U. S. 495; 62 S. Ct. 406; 86 L. Ed. 367.

Clearly such illegal effect is not avoided by the expedient of having the customer who enters into patent license agreements execute separately contracts for the unpatented welding rod to be used in connection with the licensed process. The license agreement forms and Rod Purchase Contracts were drafted so as to void any appearance of illegality, but the effective use of these agreements and related conduct shows a clear-cut violation of the anti-trust laws. See Defts. Exhs. 29 to 33, inc., 77-A to R, inc. and Defts. Exh. 98-L, the latter being a general letter to prospective customers containing the clear inference that any welding operation under a layer of flux requires a Linde license.

In any event, we submit the question to be determined is not one of fact but of law; that this Court has mistakenly treated the District Court's finding 28 as a true finding of fact, which it is not, and that to affirm such "finding," as stated by Mr. Justice Douglas in *Mercoid Corporation v. Mid-Continent Investment Co.*, 320 U. S. 661, 670, 64 S. Ct. 268, 271, 88 L. Ed. 376, 381

> "would aid in the consummation of a conspiracy to expand a patent beyond its legitimate scope."

In basing this petition for rehearing on the foregoing grounds, defendants do not waive any of the grounds heretofore urged upon this Court for reversing the decree of the District Court which held composition claims 18, 20, 22 and 23 valid and infringed and for affirming said Court's findings and conclusions that all of the process claims and composition claims 24, 26 and 27 of the patent in suit are invalid.

Wherefore, the petitioning defendants pray a rehearing to the end that justice may be done.

Petitioning defendants also pray that in the event the rehearing sought is not allowed, an order may be entered staying the issue of mandate and all proceedings herein so as to give them time and opportunity to prepare and file in the Supreme Court of the United States a petition for writ of certiorari.

Respectfully submitted,

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THE LINCOLN ELECTRIC COMPANY,
GRAVER TANK & MFG. CORP.,
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May 1, 1948.

I hereby certify that the foregoing petition is well taken in law and in fact, is filed in good faith, and should be granted.

CHARLES L. BYRON.

IN THE

United States Circuit Court of Appeals

FOR THE SEVENTH CIRCUIT.

THE LINDE AIR PRODUCTS COMPANY, *Plaintiff-Appellant,* *vs.* GRAVER TANK & MFG. CO., INC., THE LINCOLN ELECTRIC COMPANY and GRAVER TANK & MFG. CORPORATION, *Defendants-Appellees.*	No. 9481.
THE LINDE AIR PRODUCTS COMPANY, *Plaintiff-Appellee,* *vs.* GRAVER TANK & MFG. CO., INC., THE LINCOLN ELECTRIC COMPANY and GRAVER TANK & MFG. CORPORATION, *Defendants-Appellants.*	No. 9482.

APPEALS FROM THE DISTRICT COURT OF THE UNITED STATES FOR THE NORTHERN DISTRICT OF INDIANA, HAMMOND DIVISION.

PLAINTIFF'S ANSWER TO PETITION FOR REHEARING

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IN THE

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FOR THE SEVENTH CIRCUIT.

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APPEALS FROM THE DISTRICT COURT OF THE UNITED STATES FOR THE NORTHERN DISTRICT OF INDIANA, HAMMOND DIVISION.

PLAINTIFF'S ANSWER TO PETITION FOR REHEARING

Defendants by their petition for rehearing, heretofore filed, seek reconsideration of a unanimous decision by this Court, opinion by Judge Sparks. Plaintiff, The Linde Air Products Company, in answer to such petition, states:

Plaintiff will answer each of the five points relied upon in defendants' petition, in the order in which they are presented by defendants.

First, however, attention is directed to an error which is common to all five, and which makes the entire petition

for rehearing defective. Defendants are attempting to reargue points fully argued in the briefs and at the oral argument, and to which this Court has already given full consideration. Their petition should be denied as insufficient under the settled rule, stated in 12 Cyc. Fed. Proc. (2d Ed. 1944) 548, as follows:

> "It is plain that rehearing is not to be granted in disregard of the delay imposed upon other cases on the docket for the purpose of giving counsel another chance to present the cause in better manner than was done at the hearing and the petition is not to be used as a reiteration of contentions made and not upheld by the reviewing court."

In Answer to Pages 2-6, "I. The Court, by sustaining as valid the process claims of the Jones et al. patent in suit, has revived and handed over to plaintiff the prior and now expired Robinoff Patent No. 1,782,316."

This point is no more than a repetition of defendants' argument that the "prior and now expired Robinoff Patent No. 1,782,316" should be regarded as an anticipation of the Jones *et al.* process in suit. It was pleaded in defendants' answers (R. 5, 9). It was one of the principal issues at the trial, and after due consideration, the Trial Court specifically rejected defendants' contentions, stating (R. 97):

> "The evidence on the first question is clear and convincing that Jones, Kennedy and Raymond invented an important improvement in electric welding. • • • an inventive-level difference exists between their method and the automatic welding method taught by Robinoff."

The respective contentions of the parties on this point were briefed at length in this Court (see, *e.g.*, Brief for Pltf.-Appellant in No. 9481, pp. 8-9; Brief for Defts.-Appellees in No. 9481, pp. 10-13 37 *et seq.*; Brief for Pltf.-Appellee in No. 9482, pp. 34-37; and Brief for Defts.-Appel-

lants in No. 9482, pp. 14-17) and they were dealt with fully at the oral argument.

Thereafter, this Court expressly approved the Trial Court's finding that "an inventive-level difference" existed between the Jones *et al.* method and that of Robinoff (Opinion, p. 10). Judge Sparks in his opinion also called attention to the difference, both in operation and result, which distinguishes the Jones *et al.* process from that of Robinoff, stating (Opinion, pp. 16-17):

> "The court found that the patent included a novel welding process in the sense that the electric arc between the electrode and base metal is sheathed by a mantle of welding composition and that the conductive arc area is composed predominantly of vaporous welding composition; that the capabilities of the invention represented an important advance in the welding art; * * *."

Such features of the Jones *et al.* process, *completely lacking in the process taught by the Robinoff patent*, constitute the "reason * * * why Robinoff did not anticipate the Jones *et al.* process"—a reason which defendants have been unable to discern (Defts.' Petition, p. 4). These same features demonstrate the error in defendants' statement that the two processes are "identical" (Defts.' Petition, p. 5).

The fears expressed by defendants as to the effect of this Court's decision, being based upon a misapprehension of the decision, afford no ground for a rehearing.

> See, *e.g.*, *Green Bay and Mississippi Canal Co.* v. *Patten Paper Co.*, 172 U. S. 179, 189 (1899).

Defendants have failed, therefore, to give any reason why this point, which has been repeatedly and thoroughly argued and considered, should again be argued.

In Answer to Pages 6-8, "II. The Court, by sustaining as valid and infringed the composition claims of the patent in suit, has revived and handed over to plaintiff the prior Miller patent No. 1,754,566 (Deft. Exh. 145, R. 969) which expired April 15, 1947."

This point, also, reiterates an argument urged at length by defendants both upon the Trial Court and this Court, and rejected by both.

Defendants' contention is that the compositions in suit are anticipated by the Miller Patent No. 1,754,566, which expired on April 15, 1947, and it is based solely upon the fact that the flux taught by such Miller patent contains manganese silicate. Defendants disregard the complete difference in method of preparation taught by the Miller patent and the patent in suit, as a result of which the Miller flux is quite different from the compositions taught by the patent in suit. Such difference was mentioned by the Trial Court in its opinion as the reason for rejecting this same contention by defendants (R. 920-1).

This same issue was also briefed at length before this Court (*e.g.*, Brief for Defts.-Appellants in No. 9482, pp. 83-6; Brief for Pltf.-Appellee in No. 9482, pp. 16, 61), and dealt with at the oral argument.

Judge Sparks in his opinion noted with approval the following finding of the Trial Court (Opinion, p. 17):

> "* * * that manganese silicate when used as a principal constituent of a welding composition, *prepared according to the teachings of the patent*, is a proper substitute for the silicates of the alkaline earth metals." (Emphasis supplied.)

Defendants' argument is based upon a misconception as to the meaning and effect of this Court's opinion, since it fails to take into account the underlined clause in the foregoing quotation. Accordingly, their petition should be denied.

In Answer to Pages 8-12, "III. As interpreted by this Court, the process claims of the patent in suit cover merely a result, which by well established authority cannot be patented."

Defendants' third point is a play upon words. The unique *operational* characteristics of the Jones *et al.* process are called *results*.

Judge Sparks in his opinion, however, distinguished clearly between the new mode of operation of the Jones *et al.* process and its capabilities or results. No better answer to defendants' point can be made than is to be found in the following portions of his opinion, which expose the errors in defendants' contention:

> "The court found that the patent included a novel welding process in the sense that the electric arc between the electrode and base metal is sheathed by a mantle of welding composition and that the conductive arc area is composed predominantly of vaporous welding composition; that the capabilities of the invention represented an important advance in the welding art;" (Opinion, pp. 16-17.)
>
> "Plaintiff's process was quite different from that of the prior art disclosures in that the latter depended on the evolution of more gas to protect the molten metal, while plaintiff's proceeds on the theory of eliminating all gas forming ingredients. That difference is clearly one of process. True, plaintiff's process contemplated and depended upon a different composition of flux, and the patent was issued on both process and flux composition, and we think rightly so. There are as many different kinds of flux as there are elements and combinations of elements, and when thus used their results are quite as numerous. However, this patent was not granted upon a result, but it was granted upon a process or method which produced a much desired result, and which was then unknown to the art. Any other proc

ess or method which produces the same result would not infringe this process patent, provided it does not use this method or its equivalent, and this would be true regardless of what flux, if any, was used for such purpose." (Opinion, p. 16.)

In Answer to Pages 12-14, "IV. By treating conclusions of law as if they were findings of fact and upholding them upon the basis that there is something in the record to support them, while at the same time completely disregarding true findings of fact by the District Court, this Court has departed from the accepted and usual course of judicial proceedings."

Under this heading, defendants have collected a miscellany of arguments, which will be answered in the order in which they were made.

1.

Defendants first contend that the Court failed to give due effect to the Trial Court's Findings Nos. 26 and 27 relating to the "procedural steps" followed in the Robinoff and Jones *et al.* processes (Defts.' Petition, p. 12). This is still another reiteration of their familiar argument that Robinoff anticipated Jones *et al.* Its error has already been shown in our answer to defendants' first point (pp. 2-3, above).

The inventive-level difference of Jones *et al.* over Robinoff consisted not in the manipulatory steps upon which defendants rely, but in its different mode of operation,—by an arc sheathed by a mantle of molten composition and composed predominantly of vaporous welding composition. These features of the new process are specifically covered in the Trial Court's Finding No. 7 (R. 924).

This Court's express affirmance of such finding (Opinion, pp. 12, 16-17) is entirely consistent with the Trial Court's Findings Nos. 26 and 27, when such findings are read in the light of the Trial Court's own Finding No. 7.

2.

The same facts serve to answer defendants' reliance upon the Trial Court's Finding No. 15 (Defts.' Petition, pp. 12, 13). That finding also must be construed in the light of the Trial Court's own Finding No. 7, which was fully supported by the record (see, *e.g.*, Brief for Pltf.-Appellant in No. 9481, pp. 13-19).

3.

Defendants' statement that the Trial Court expressly found no invention as to the process (Defts.' Petition, p. 12) is, of course, a misstatement of the record. The Trial Court discussed the question whether the inventors had invented a new process, as well as new compositions, and specifically held: "Therefore, a new process of welding has been discovered" (R. 913).

4.

Defendants also assert that this Court improperly treated as findings of fact the Trial Court's Findings Nos. 14 and 24, relating to the substitution of manganese silicate for the silicates of the alkaline earth metals (Defts.' Petition, pp. 13-14). The assumption in which defendants indulge in making this contention is amply refuted on the face of this Court's opinion, which clearly indicates the thorough study which was given to the specifications of the patent in suit (see, *e.g.*, pp. 2-9; 14-16).

Defendants' view that Findings Nos. 14 and 24 should be regarded as interpretations of the patent, rather than findings of fact, was expressed in their brief before this Court (Brief for Defts.-Appellants in No. 9482, pp. 28-9). All relevant questions of construction and of fact bearing on the issue of substitution were fully briefed by the respective parties (see Brief for Defts.-Appellants in No. 9482, pp. 28-30, 68-72; Brief for Pltf.-Appellee in No. 9482, pp. 18-23, 30-1, 55-9).

Obviously, insofar as the Trial Court's construction of the patent was embodied in Finding No. 24 or in the others referred to by defendants, this Court agreed with such construction. This applies equally to Finding No. 14, although defendants' specific assertion that such finding was treated by this Court as a finding of fact is difficult to understand. Finding No. 14 is neither referred to nor paraphrased anywhere in this Court's opinion.

In Answer to Pages 15-17, "V. In adopting the District Court's finding that plaintiff does not impose as a condition of the license under the patent in suit, nor does it ever impose on its licensees requirements which constitute a misuse of said patent, this Court has ignored the legal effect of the admitted facts as to plaintiff's conduct."

By defendants' own statement, the principle of law established by the decisions upon which they rely under their fifth point (Defts.' Petition, p. 16) is no more than that: "a patentee *may not impose, as a condition of a license*, that the purchaser use unpatented supplies furnished by the patentee" (emphasis supplied) (Brief for Defts.-Appellants in No. 9482, p. 103).

In substantially the same terms as they now employ in their fifth point, defendants sought to persuade the Trial Court that the record in this case brought it within the aforesaid principle. After a full hearing, that Court concluded (R. 922):

> "* * * it is hard to conceive what more plaintiff could have done to safeguard itself from charges of having unduly broadened its patent monopoly."

Thereafter, the parties repeated their arguments before this Court (Brief for Defts.-Appellants in No. 9482, pp. 102-7; Brief for Pltf.-Appellee in No. 9482, pp. 72-5), which thereupon unanimously approved the Trial Court's findings (Opinion, p. 18).

Here, again, defendants fail to suggest any useful purpose which would be served by permitting them once more to go over the same ground. Under this point, as under all the rest, they have been unable to point to any rule of law or fact of record which has been overlooked.

Defendants' petition for rehearing is nothing more than a request for a reargument, and it should be denied.

Respectfully submitted,

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[fol. 1012] UNITED STATES CIRCUIT COURT OF APPEALS FOR THE SEVENTH CIRCUIT, CHICAGO 10, ILLINOIS, MAY 14, 1948

Before Hon. William M. Sparks, Circuit Judge; Hon. J. Earl Major, Circuit Judge; Hon. Sherman Minton, Circuit Judge

Nos. 9481 & 9482

THE LINDE AIR PRODUCTS COMPANY, Plaintiff-Appellant in 9481, Plaintiff-Appellee in 9482,

vs.

GRAVER TANK & MFG. CO., INC., THE LINCOLN ELECTRIC COMPANY AND GRAVER TANK & MFG. CORPORATION, Defendants-Appellees in 9481, Defendants-Appellants in 9482

Appeal from the District Court of the United States for the Northern District of Indiana, Hammond Div.

It is ordered by the Court that the petition for a rehearing of this cause be, and the same is hereby, denied.

[fol. 1013] And afterwards, to-wit, on the nineteenth day of May, 1948, there was filed in the office of the Clerk of this Court a motion for additional security by the plaintiff which said motion is not set-forth here.

[fol. 1014] UNITED STATES CIRCUIT COURT OF APPEALS FOR THE SEVENTH CIRCUIT, CHICAGO 10, ILLINOIS

Nos. 9481 & 9482

THE LINDE AIR PRODUCTS COMPANY, Plaintiff-Appellant and Plaintiff-Appellee,

vs.

GRAVER TANK & MFG. CO., INC., THE LINCOLN ELECTRIC COMPANY and Graver Tank & Mfg. Corporation, Defendants-Appellees and Defendants-Appellants

Appeals from the District Court of the United States for the Northern District of Indiana, Hammond Division

May 26, 1948

Before Hon. William M. Sparks, Circuit Judge

On motion of counsel for the defendants, it is ordered that the issuance of the mandate of this Court in this cause be, and the same is hereby, stayed to and including June 29, 1948.

It is further ordered that the motion of counsel for the plaintiff for an order requiring the defendants to provide additional security, under the terms and conditions of their Supersedeas Bond heretofore filed in this cause, be, and the same is hereby, denied.

[fol. 1015] [Stamp:] U. S. C. C. A.—7. Filed Jun. 14, 1948. Kenneth J. Carrick, Clerk

IN THE UNITED STATES CIRCUIT COURT OF APPEALS FOR THE SEVENTH CIRCUIT

Nos. 9481 and 9482

THE LINDE AIR PRODUCTS COMPANY, Plaintiff-Appellant in No. 9481, Plaintiff-Appellee in No. 9482,

vs.

GRAVER TANK & MFG. CO., INC., THE LINCOLN ELECTRIC COMPANY and Graver Tank & Mfg. Corporation, Defendants-Appellees in No. 9481, Defendants-Appellants in No. 9482

DESIGNATION

In accordance with Rule 13 of the Rules of the Supreme Court of the United States, defendants, Graver Tank & Mfg. Co., Inc., The Lincoln Electric Company and Graver

Tank & Mfg. Corporation, hereby designate, in addition to the record submitted to the Circuit Court of Appeals for the Seventh Circuit on appeal, the following papers and documents forming parts of the record of the proceedings in said Circuit Court, for the consideration of the Supreme Court of the United States:

1. Order taking cause under advisement entered February 13, 1948.

2. Opinion filed April 16, 1948.

3. Judgments entered April 16, 1948.

4. Petition for rehearing filed April 30, 1948.

5. Answer to petition for rehearing filed May 10, 1948.

[fol. 1016] 6. Order denying rehearing entered May 14, 1948.

7. Reference to motion for additional security filed May 19, 1948.

8. Order staying mandate and denying motion for additional security entered May 26, 1948.

9. This designation for Supreme Court record entered ——.

Charles L. Byron, First National Bank Building, Chicago 3, Illinois; John F. Oberlin, Leader Building, Cleveland 14, Ohio; Ashley M. Van Duzer, James R. Stewart, Terminal Tower, Cleveland 13, Ohio, Attorneys for Defendants.

Service of the above Designation is hereby acknowledged this 14th day of June, 1948.

(Signed) Carlson, Pitzner, Hubbard & Wolfe, Attorney for Plaintiff.

[fol. 1017] UNITED STATES CIRCUIT COURT OF APPEALS FOR THE SEVENTH CIRCUIT

I, Kenneth J. Carrick, Clerk of the United States Circuit Court of Appeals for the Seventh Circuit, do hereby certify that the foregoing typewritten pages contain a true copy of proceedings had and papers filed in this Court and made in accordance with Defendants' designation of record filed in this Court on the fourteenth day of June, 1948, in Cause No. 9481 & 9482, The Linde Air Products Company, Plain-

tiff-Appellant in 9481, Plaintiff-Appellee in 9482, vs. Graver Tank & Mfg. Co., Inc., The Lincoln Electric Company and Graver Tank & Mfg. Corporation, Defendants-Appellees in 9481, Defendants-Appellants in 9482, as the same remains upon the files and records of the United States Circuit Court of Appeals for the Seventh Circuit.

In testimony whereof I hereunto subscribe my name and affix the seal of said United States Circuit Court of Appeals for the Seventh Circuit, at the City of Chicago, this Seventeenth day of June A. D. 1948.

Kenneth J. Carrick, Clerk of the United States Circuit Court of Appeals for the Seventh Circuit. By R. Hays Blanchard, Chief Deputy Clerk. (Seal.)

[fol. 1038] [Stamp:] U. S. C.-C. A.-7. Filed Jul. 13, 1948. Kenneth J. Carrick, Clerk

IN THE UNITED STATES CIRCUIT COURT OF APPEALS FOR THE SEVENTH CIRCUIT

Nos. 9481, 9482

THE LINDE AIR PRODUCTS COMPANY, Plaintiff-Appellant in No. 9481; Plaintiff-Appellee in No. 9482,

vs.

GRAVER TANK & MFG. CO., INC., THE LINCOLN ELECTRIC COMPANY and Graver Tank & Mfg. Corporation, Defendants-Appellees in No. 9481; Defendants-Appellants in No. 9482

STIPULATION FOR RECORD UPON REVIEW IN THE SUPREME COURT OF THE UNITED STATES.

It is stipulated by and between the parties hereto:

1. That the record upon the review of these causes by the Supreme Court of the United States shall consist of:

(a) The printed record filed before the Circuit Court of Appeals;

(b) All of the exhibits included in the record before the Circuit Court of Appeals which, pursuant to the stipulation of the parties, were omitted from the printed record as more fully set forth and identified in the stipulation of the parties covering the record upon appeal appearing at pages 952-954 of the printed record filed before the Circuit Court of Appeals;

(c) Proceedings in said Circuit Court of Appeals as follows:

[fol. 1039] (i) Order taking cause under advisement entered February 13, 1948;

(ii) Opinion filed April 16, 1948;

(iii) Judgments entered April 20, 1948;

(iv) Petition for rehearing filed April 30, 1948;

(v) Answer to petition for rehearing filed May 10, 1948;

(vi) Order denying rehearing entered May 14, 1948;

(vii) Reference to motion for additional security filed May 19, 1948;

(viii) Order staying mandate and denying motion for additional security entered May 26, 1948, and order entered June 14, 1948, enlarging the stay;

(d) This stipulation.

2. That, pursuant to Paragraph 8 of Rule 38 of the Rules of the Supreme Court of the United States:

(a) The printed record upon the review before the Supreme Court of the United States shall include:

(i) The printed record as filed in the Circuit Court of Appeals;

(ii) The proceedings above specified upon said review before said Circuit Court of Appeals;

(iii) This stipulation;

(b) The other exhibits included in the record upon review [fol. 1040] to be lodged with the Supreme Court of the United States but need not be included in the printed record.

Charles L. Byron, John F. Oberlin, Ashley M. Van Duzer, James R. Stewart, by (Signed) Charles L. Byron, Attorneys for Graver Tank & Mfg. Co., Inc., The Lincoln Electric Company, and Graver Tank & Mfg. Corporation, John T. Cahill, Richard Russell Wolfe, James A. Fowler, Jr., Loftus E. Becker, by (Signed) Richard Russell Wolfe, Attorneys for The Linde Air Products Company.

[fol. 1041] UNITED STATES CIRCUIT COURT OF APPEALS FOR THE SEVENTH CIRCUIT

Chicago 10, Illinois,
July 13, 1948.

Before Hon. William M. Sparks, Circuit Judge

Nos. 9481 & 9482

THE LINDE AIR PRODUCTS COMPANY, Plaintiff-Appellant and Plaintiff-Appellee,

vs.

GRAVER TANK & MFG. CO., INC., THE LINCOLN ELECTRIC COMPANY and Graver Tank & Mfg. Corporation, Defendants-Appellees and Defendants-Appellants

Appeals from the District Court of the United States for the Northern District of Indiana, Hammond Division

It is ordered that the stipulation of counsel, filed this day in the above entitled cause, relative to the contents of the record upon review in the Supreme Court of the United States be, and the same is hereby, approved.

[fol. 1042] UNITED STATES CIRCUIT COURT OF APPEALS FOR THE SEVENTH CIRCUIT

I, Kenneth J. Garrick, Clerk of the United States Circuit Court of Appeals for the Seventh Circuit, do hereby certify that the foregoing typewritten pages contain a true copy of the stipulation for record upon review in the Supreme Court of the United States filed in this Court on the thirteenth day of July, 1948, and the order of this Court approving said stipulation entered on the thirteenth day of July, 1948, in Cause No. 9481-9482, Linde Air Products Company, Plaintiff-Appellant, and Plaintiff Appellee, vs. Graver Tank & Mfg. Co., Inc., The Lincoln Electric Co., and Graver Tank & Mfg. Corporation, Defendants-Appellees, and Defendants-Appellants, as the same remains upon the files and records of the United States Circuit Court of Appeals for the Seventh Circuit.

In testimony whereof I hereunto subscribe my name and affix the seal of said United States Circuit Court of Appeals for the Seventh Circuit, at the the City of Chicago, this twenty-ninth day of July, A. D. 1948.

Kenneth J. Carrick, Clerk of the United States Circuit Court of Appeals for the Seventh Circuit, by R. Hays Blanchard, Chief Deputy Clerk. (Seal.)

[fol. 1043] Supreme Court of the United States, October Term, 1948

No. 184

Order Allowing Certiorari—Filed October 11, 1948

The petition herein for a writ of certiorari to the United States Court of Appeals for the Seventh Circuit is granted.

And it is further ordered that the duly certified copy of the transcript of the proceedings below which accompanied the petition shall be treated as though filed in response to such writ.

[fol. 1044] Supreme Court of the United States, October Term, 1948

No. 185

Order Allowing Certiorari—Filed October 11, 1948

The petition herein for a writ of certiorari to the United States Court of Appeals for the Seventh Circuit is granted.

And it is further ordered that the duly certified copy of the transcript of the proceedings below which accompanied the petition shall be treated as though filed in response to such writ.